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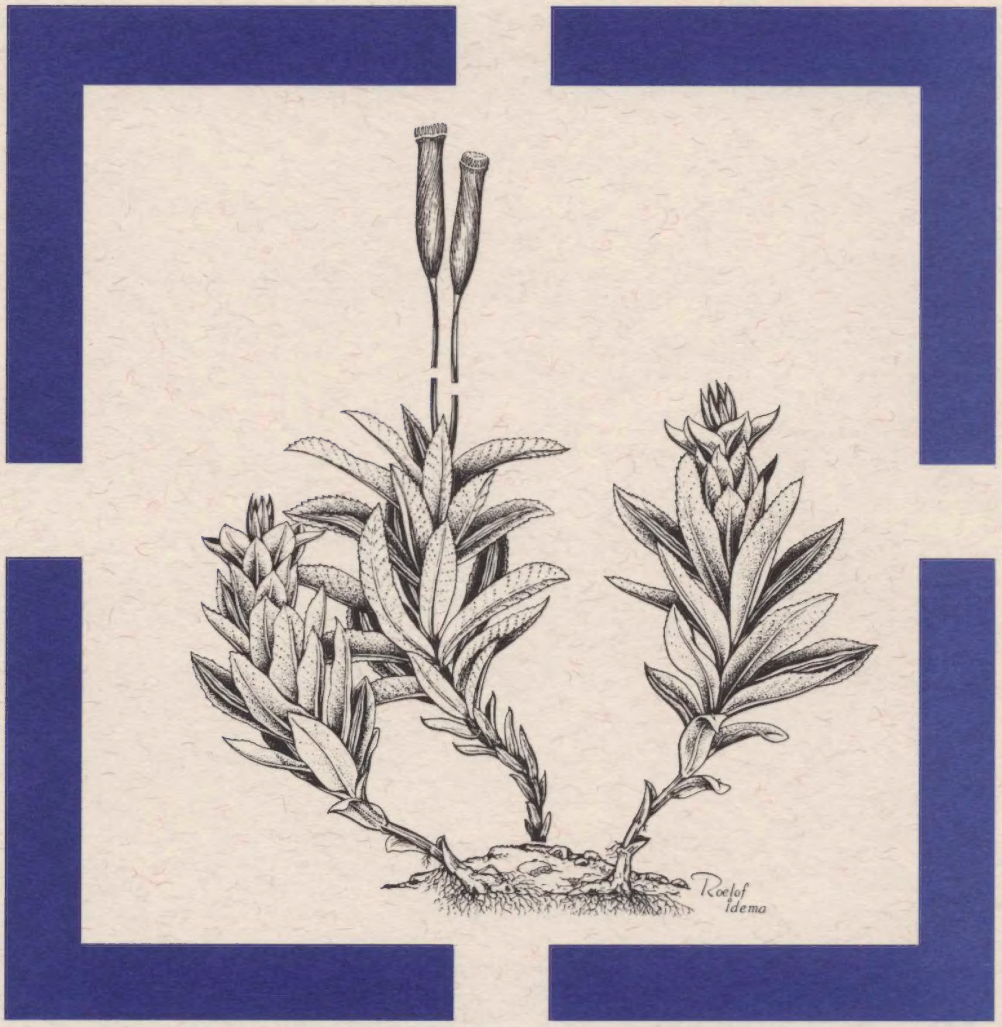

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research, conservation, education and wise use

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The goals of Canadian Biodiversity are to:

* *Publish articles, views and news on biodiversity*

* *Bridge the gaps between professional disciplines & the public*

* *Communicate information on Canadian & world biodiversity*

* *Express views on the needs & value of biodiversity research*

* *Discuss methods and philosophy of biodiversity conservation*

* *Review books and major articles on biodiversity*

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TABLE OF CONTENTS

PAPERS

Diversity and conservation of ornamental fishes - the gems from flooded forests in Amazonia

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INTRODUCTION

How many fishes are there in the great Amazon Basin? So far, about 1,500 species are catalogued. A final total is estimated to be somewhere between 2,500 and 5,000 species (Böhlke, et al, 1978; Goulding, 1980). This is several times greater than the 1,000 species known from freshwaters of North America. Many undescribed Amazon fishes are waiting for scientific names in museum collections and live aquaria, and more in the wild.

In spite of their diversity, fishes are probably the least celebrated of aquatic animals. Parks usually prohibit hunting animals and removing plants, but more than often than not, visitors are allowed to fish or buy a fishing license. In general, fewer fishes are registered as threatened or endangered, and fish sanctuaries are rare. Aquatic ecosystems are often exposed to considerable environmental stress unnoticed, until the fish turn belly up. As long as the public still thinks that the rivers of the Amazon are infested with ferocious piranhas, a campaign to "SAVE THE AMAZON FISHES," may sound like "SAVE THE PIRANHAS", and not appeal to the public.

The potential impacts of deforestation on the Amazon rainforest are well-documented (Cowell, 1990). The problem has been linked to much broader environmental issues, such as global warming and the loss of species. Most conservation projects are directing toward firm land forests, often on the impacts of slash-and-burn agriculture and ranching. Much less attention has been given to the flood-plain forests, wetlands or other aquatic ecosystems, which cover 2% of the 7 million km^2 Amazonia. Biodiversity concerns are focussed mainly on terrestrial animals and plants, while only few species of aquatic mammals and reptiles are so honored.

FISHES AS A FOREST PRODUCT

The flood-plain forest serves as a refuge and nursery for many aquatic and terrestrial animals (mainly fishes and insects). It is a critical habitat for the recruitment processes of aquatic fauna during the rainy season. White water rivers and ***várzea*** (flood plain) lakes provide 90% of food fish for Amazonians, 150,000 metric tonnes/year. Blackwater streams and ***igapós*** (flooded forest) supply 90% tropical fishes for export, up to 21 million fishes per year (**Fig.1**). Officially, the ornamental fish export generates annually one million US dollars for the region annually (about 2 million dollars in 1991). Eight to ten thousand Amazonians depend on this economy for subsistence.

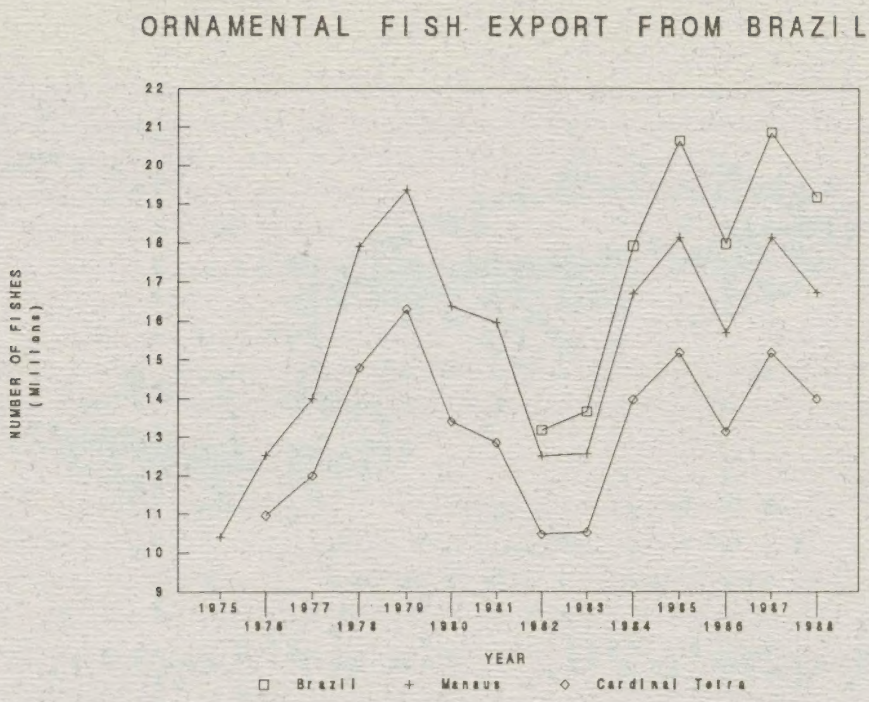

Figure 1. *Number of ornamental fishes exported from Brazil, Manaus, Amazonas. Export numbers of cardinal tetra are estimated for 1985 to 1989.*

Ornamental fishes are usually small and colorful fishes kept in aquaria or ponds for display, education or decorative purposes. Some are large and exotic, and most have a tropical origin. Forest streams and lakes in the tributaries of the mid Rio Negro are the main fishing grounds for 10-20 million fishes exported from Manaus annually (Chao, et al., *in press*). Among them, 80% are cardinal tetras (**Fig. 2**), *Paracheirodon axelrodi*, endemic to the mid and upper Rio Negro. About 60 species are regularly exported as ornamental fishes from Manaus, many more are not identified or are misidentified. Exporters suffer a fish loss of 30% while fishes are in their hands. Fishers may have a greater loss on their unsold fishes. My estimate is that between 30-40 million tropical fish change hands in Central Amazon each year. Annually, more than 50 million forest fish are removed from their natural habitats.

The trading post of ornamental fish, Barcelos, is a 200 year old riverine town, 430 km up Rio Negro from Manaus. Six thousand of the 8,000 residents are somehow linked to the trade. Other extractive natural resources are Brazil nuts, palm hearts and piassava fibers. Last year, the palm heart tree, *Astocaryum jauary*, became scarce. The palm heart factory in Barcelos, the only other industry, began to make canned pineapple paste as well. The piassava fibers have been harvested from distant indigenous reservations for years. The fate of ornamental fish has veteran fishers and local politicians worried.

A typical fishing trip takes one or two weeks. Fishers first journey in a wooden river boat, usually 15-18 m long with a 15-30 hp diesel engine, to a tributary of their preference. After reaching the mouth of a forest stream, ***igarapé***, a fisher or two would paddle a dugout into the ***igapó***. They look for schools of cardinal tetras, whose metallic blue stripes are easily sighted in the dim forest. Holding a large dip-net in one hand and an oar in the other, a fisher carefully herds the fish into the net. The fishery is artisanal, but one needs fine skill, patience and an awareness of the surroundings. Boys start fishing in their early teens. Women always stay on the boat caring for fishes and men. Fishing activity is reduced when it rains.

Figure 2. *Cardinal tetra, **Paracheirodon axelrodi**, endemic to tributaries of mid Rio Negro.*

Live fishes are kept in a trough-like reservoir made of nylon screen. Later, all of the fishes are sorted and put into the stackable plastic tubs measuring 54 x 36 x 20 cm, for transport. Each tub can hold 400 to 1,200 live fishes, depending on the size and species. Exporters buy fishes in Barcelos on Sunday. During the high fishing season (October to February), more than one thousand tubs are shipped to Manaus weekly. That's a million live fish! Can the river-forest ecosystem sustain this fishing pressure?

Fishers also take food fishes, gather Brazil nuts and wild fruits, and hunt forest animals while cruising through the ***igarapés***. Side-neck turtles (*Peltocephalus tracaxa*), waterfowl, howler monkeys, paca (a large aquatic rodent) and manatees are their favorites. At times, these animals become the main source of sustenance during the off fishing seasons. Thus, the lower catches in the ornamental fishery may cause even greater damage to other threatened animals of the region.

NATURAL HISTORY

Since 1989, my students and I, at the Universidade do Amazonas and Instituto Nacional de Pesquisa Amazônica (INPA), Brazil, have developed a research project on "**Ornamental fishes of Rio Negro**." Our goal is to solve the technical problems and find an integrated management strategy to keep the fishery sound, both commercially and ecologically. Introducing simple techniques to improve water quality and treat parasites could reduce mortality drastically during transportation. Long-term remedies include: introducing unexploited species of fishes to the hobby, establishing export ceilings for some, and enhancing the natural stocks.

We have made several expeditions into the tributaries of mid Rio Negro. A two week study can yield a hundred species (**Table 1**). Repetitive samples made at different seasons around a wetland area (11,000 km^2) have totaled more than 160 species (Chao, *et al.*, in press). Most fishes are different from the 450 species reported by Goulding, *et al.* (1988) from the Rio Negro. Fishes of the flooded forest and swampy wetland have not been studied regularly. New and rare species are frequently found in our samples. It will not be surprising if the total diversity of Rio Negro fishes will exceed 1,000 species.

We also made field experiments to test the effects of depth, habitat and bait on ***igapó*** fishes. More fishes were caught in upper layers of the water column, less than 25 cm from the surface. Baited traps captured more cardinal tetras then all other fishes combined (Chao & Prada-Pedereros, in press). Fishers also use fried fish guts and flesh nuggets to attract cardinal tetras. Cardinal tetras, other popular characins and dwarf cichlids are present in diverse habitats, are often associated with submerged aquatic weeds and leaf litter. The physical and chemical parameters of the waters vary slightly in the ***igarapé*** and ***igapó***; water temperature, 24-29 °C; conductivity, 5.8-20 μS; pH, 3.4-4.5; dissolved oxygen, 0.6-3.3 mg/l. This "black" water is very soft and has a humic acid amber colour. It is potable and often referred to as slightly tanned distilled water. Because of this, there are usually fewer biting insects in the region, except for part of the rainy season. The *Anopheles* mosquitos are as hungry as those of the subarctic summer camps.

The annual flood expands the feeding range of ornamental fishes further into the rainforest. Although the water is often poor in nutrients and plankton, there are several external sources, *e.g.* falling leaves, fruits and insects. Other energy processes in the ***igapó***, such as decomposition of bottom litter and input from the firm land run offs, have received little study. It does not appear to us that either the biomass or diversity of ***igapó*** fishes are less than their white water counterpart. The ***igapó*** fish assemblage shows a similar pattern of composition to some warm temperate lakes and estuaries. That is, a few dominant taxa make up a major portion of the fish community.

With few exceptions, most ornamental fishes are caught with cardinal tetras. The cardinal tetra is of particular concern to the fishery and the ecosystem; thus is chosen as the indicator species (Soulé & Kohm, 1989). These tetras are usually found in school of 12-30 fishes, cruising in the shallow waters (< 40 cm) on the margin of ***igarapé*** and in the ***igapó***. During the low water season, cardinal tetras move down to the margin of lower reach lakes (**lagos-ria**) of the ***igarapés*** or are concentrated in backwaters. In the flood season, they move to the headwater lake (**campo**) and flooded forest with the expanding water mass. In extreme dry years, local fishers said that cardinals may drop down river 20-50 km from the tributaries to the margin of Rio Negro.

Most ***igapó*** fishes are annual fishes, spawning during the flood, when the eggs and larvae can disperse further. They are well-adapted to high temperature, low oxygen and strong acid waters. They usually do not show specific habitat preferences. The present fishing methods are very selective and non-predatorial. Therefore, I believe that **the species diversity of the igapó fishes is not presently threatened, but as a renewable resource there are difficulties ahead**. This assumes, of course, that the essential riverine and flood-plain forest habitat is not degraded or destroyed. Socio-economic problems often prompt bureaucrats and politicians to make concessions which often sacrifice environmental causes for immediate capital gains. It is also clear that the conservation of ornamental fishes and the forested wetlands is not an ecological issue, nor a responsibility of scientists alone.

CONSERVATION AND SUBSISTENCE

The ornamental fishery and export of Central Amazon began to boom in the early 60s, owing to the joint efforts of Dr. Herbert R. Axelrod of Tropical Fish Hobbyist, New Jersey and the late Sr. Willi Schwatz of Tukeys Aquario, Manaus. In recent years, fishers have had to journey to distant tributaries for their catch, as nearby stocks diminished. They also suffered from economic exploitation, *e.g.* a thousand cardinals sold to an exporter for only US$2.00 in October, 1991, when inflation was 20% for the month.

As the earning power of fishers diminished, some opted to practice slash-and-burn agriculture. Others moved to the slums of the urban center, Manaus. Can a managed fishery lessen the environmental and socio-economical burdens?

The government environmental agency (IBAMA, Instituto Brasiléiro do Meio Ambiente e dos Recursos Naturais Renovaveis) has tried to regulate the catch and export of ornamental fishes through decree laws. Examples are: prohibit cardinal fishing and trading during the spawning season (May to July); embargo on export of food species as ornamental fishes; and restrict exports are restricted to a list of only 86 species. The ambiguity of the regulations and the lack of enforcement have caused many irregularities in the market and has lost export revenues. Recently, IBAMA has changed the regulations, by replacing the "good" list policy with a "bad" list of prohibited species. Most food fishes remained on the new prohibited list, and the threatened pirarucu (listed in CITES), *Arapaima gigas*, is among them.

The ornamental fish fishery of the Rio Negro is also threatened by the aquaculturists around the world. The South American export of the neon tetra (*P. innesi*), closely related to the cardinal tetra, has diminished because of competition from new breeding stocks in the Far East. Several strains of highly valued discus cichlids (*Symphysodon* spp.) are bred in Asia, Europe and North America, but not in South America. The breeders often offer healthier and prettier fishes at an affordable price. Although the aquarium hobbyists around the world have an endless quest for new fishes, many countries have tight restrictions on exotics. Can the subsistence fishery of ornamental fishes survive?

The ornamental fish industry has tied the subsistence of Amazonian fishers to the hobbyists throughout the world. The public aquaria have already played a significant role in environmental education and conservation. The ornamental fish industry is not one that I would call "GREEN" conscious. Worldwide, more than 150 million ornamental fishes are sold each year, the trade in fishes and aquarium accessories is in excess of $7 billion US (Andrews, 1990). The industry has not yet made significant contributions to the conservation of the habitat of wild fishes, nor to the protection of native fishes from the exotics. But I believe that the industry and hobbyists can take a more active role in the conservation of tropical fishes and their natural habitats. Can the industry and hobbyists be motivated? I believe it is possible.

Initially, we first received support from an exporter in Manaus, Sr. Sebatião Corrêa, then from Dr. Herbert Axelrod (of T.F.H.). In 1991, Brazilian CNPq (National Research Council) granted funds for equipment, material and student scholarships. Recently, a group of North American aquarists have financed and participated in one of our research expeditions. The Ornamental Fish Exporters Assciation of Amazonas (ACEPOAM) has agreed to donate 2% of the value of their exports toward research, conservation and other social-economic goals. The combined support from different sectors of the ornamental fish industry and the government agencies have made the project possible.

To study and conserve Amazon fishes and rivers, we have set up a non-profit organization, **Bio-Amazônia Conservation International**, in Florida and Amazonas. We like to invite scientists to join us to learn the Amazon river-forest ecosystems. We welcome tropical fish hobbyists and concerned individuals to participate in our expeditions, as supporting volunteers.

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How global warming affects species survival

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INTRODUCTION

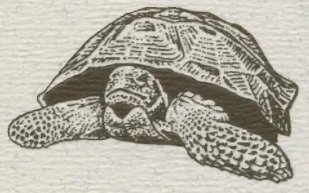
How will global warming from the greenhouse affect survival of a species? Why can't species just adapt to a warmer temperature? Why can't a species just move to a cooler place? How great will the effects be? What magnitude of effects can be expected on species survival? These are some of the questions to which we must find answers if we are to appreciate the impacts of climate warming on the planet's biodiversity or natural wealth.

Scientists are in agreement that the increase in atmospheric levels of carbon dioxide and other greenhouse gases has caused global warming; and that this trend will continue until we can arrest the increase in greenhouse gases. The exact rate of future warming is difficult to calculate because the global climate system is complex, e.g., the melting of sea ice will decrease the amount of sunlight reflected into space and speed up global warming, but it is difficult to predict exactly when the polar sea ice will be gone; warming may be accompanied by development of more clouds that will increase reflection of sunlight into space and moderate warming, but the degree of cloud development is uncertain. Calculations do suggest that warming over the Earth's surface will not be even, some areas will be hotter and some will be cooler (Jones and Wigley 1990). It will be the **average** temperature of the globe that will be warmer. This means that some areas will be much hotter.

The impacts of warming will be complicated by secondary effects such as the melting of glaciers and the thermal expansion of ocean waters which will raise ocean levels (Lyman 1990, p. 58), with their own impacts, changes in precipitation and river flow, modified seasonal patterns, changes in vegetation patterns, etc. The needs of all life history stages of a plant or animal must be met if it is to survive. If spawning grounds for salmon are lost, it will not matter if the needs of alevins (hatchlings), smolt, grilse and adult life history stages are met.

HOPE FOR ADAPTION TO HIGHER TEMPERATURES?

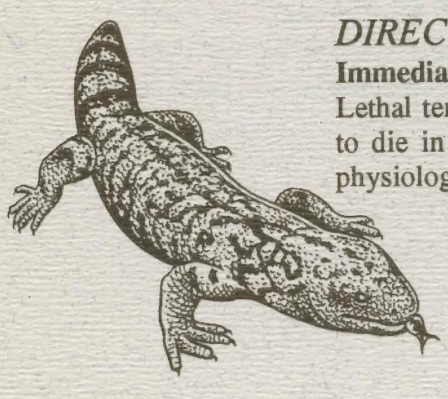
Gradual warming may acclimatize some or all individuals of a species to tolerate higher temperatures. This is like the physiological adaptation that we undergo seasonally from cold winters to warm summers, or when we move to a warmer climate. But there is a warming rate and temperature level beyond which a species will be unable to acclimatize. When temperatures increase over decades or centuries, selection will favor survival of those individuals which are able to tolerate higher temperatures. This is a genetic adaptation. But even genetic adaptation has its limits when the rate of climate warming is rapid. Parsons (1989) concluded that extinction and replacement of rare tropical rain-forest species of *Drosophila* is likely if temperature increases by as little as 2°C. Lowland tropical species are often adapted to a narrow range of temperatures. It seems likely that if the warming trend continues at its present rate there is little doubt that we will lose thousands of species. Already a number of populations of reef corals have been impacted during the El Nino events of 1982 and 1983 (Glynn, Cortés, Guzman and Richmond 1988).



We can divide the effects into direct and indirect. Direct effects are those which impact the physiology of the species. Indirect effects are those impacts which affect the resources such as food or the habitat that a species needs to survive.

DIRECT EFFECTS

Immediate impacts



Lethal temperatures are those which cause all or a sensitive proportion of a population to die in a given period. Temperature in this case interferes with one or more vital physiological processes, such as respiration, and the individual dies quickly.

Delayed impacts

Delayed impacts are those caused by temperature stresses that do not immediately kill the individual. Heat stress may mean that energy is diverted to keeping a bird cool or to expend more time in seeking water. That diversion of energy may mean that sufficient fat is not deposited to complete migration, and death ensues when the bird falls into the ocean or is stranded in inappropriate habitat. Impacts may be delayed a generation or more when stress impacts reproduction. Lower numbers or quality of young may be produced, or none at all.

Meisner *et al* (1987) report that fish tend to choose thermal regimes which will maximize their net rate of energy gain. They concluded that habitat warming in the Great Lakes Basin would likely shrink basin populations of salmons, trouts and whitefishes (Salmonidae), and allow range extensions of minnows (Cyprinidae), pikes (Esocidae), sunfishes (Centrarchidae), and catfishes (Ictaluridae). They expected changes in fisheries yields of preferred species.

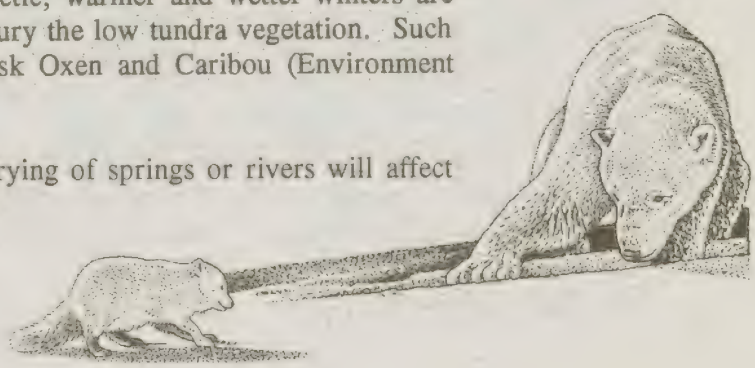
INDIRECT EFFECTS

Indirect effects may cause extinction, even if direct effects do not. Potential indirect effects are numerous. Some effects are specific to the species, so the following list should not be regarded as exhaustive. One should appreciate that the resources a species needs for survival have to be coordinated with it in place and time. For example temperature increases may displace a bird northwards, but the necessary forest habitat will, assuming survival, move northward slowly. Plankton blooms must occur at the right time of year if larval fishes are to feed and survive. Patalas (1990) found climate is very important in determining plankton diversity, and that temperature is the most important limiting factor.

Warmer temperatures are only one of the expected effects of global warming. Precipitation regimes are also expected to change. Some environments, such as mountains, lakes and rivers, are discontinuous. Depending on migrating ability and the filter effect of intervening unsuitable environment, species may or may not be able to disperse to new habitats. Many fish species will be unable to migrate northwards from one water basin to another; the divides between basins are barriers. For example, basins in the Tennessee-Cumberland plateau contain a large proportion of North American species of freshwater fishes (McAllister *et al*. 1986), and fish species may be unable to move north into the Ohio drainage, let alone into the Great Lakes-St. Lawrence River drainage basin.

1. **Food**. A species will be affected if an important food supply is lost, e.g., wintering forage for mountain sheep in valleys. In the Arctic, warmer and wetter winters are expected, with very heavy snowfalls that would bury the low tundra vegetation. Such winters have already had severe impacts on Musk Oxen and Caribou (Environment Canada 1990).

2. **Drinking water**. Droughts, desertification, drying of springs or rivers will affect those species requiring a source of drinking water.



3. **Habitat**. The loss of habitat, such as forests, grasslands, coral reefs or lakes, will impact many species. Habitat may provide many resources, some subtle in our eyes, e.g. shelter from predators, wind and waves; shade; oxygen; appropriate salinities; courtship, spawning, and nursery areas; corridors between seasonal summering and wintering grounds; nest-making materials; terrain for burrows; or sufficient humidity. Meisner *et al* (1987) concluded that rapid changes in Great Lakes water level would adversely affect the structure of wetlands and littoral areas, reducing their efficacy as spawning and nursery areas; one would expect nesting success of certain ducks would also be affected.

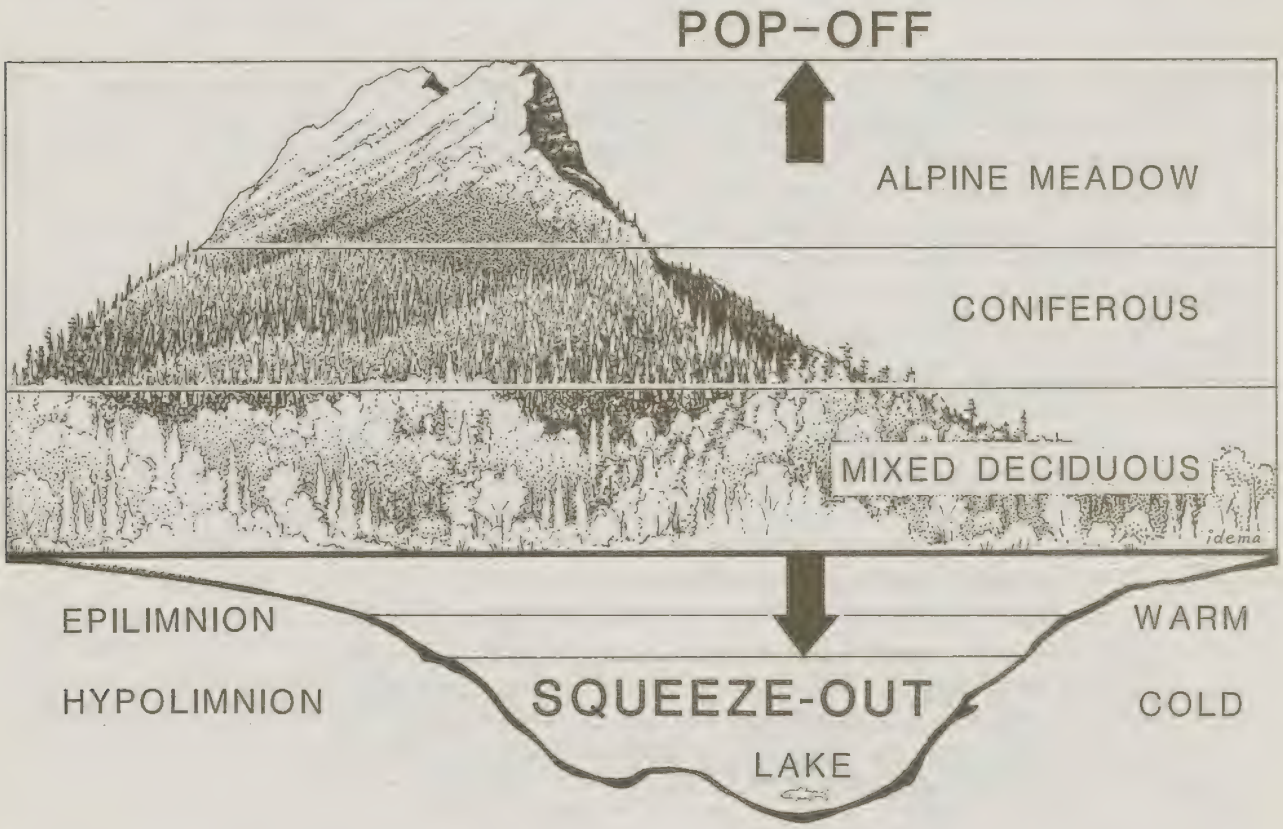
The warming of ocean waters will probably result in increased frequency and strength of hurricanes and other storms. Increased wave action will increase loss of coral reef and mangrove habitat, magnifying effects of sea level rise.

A common effect of climate warming will be shrinkage of habitat in the south and addition of habitat in the north. For example, according to Meisner (1990) brook trout (*Salvelinus fontinalis*) habitat, given a 3.8°C climatic increase, will be displaced upwards by about 700 metres. If populations remained at the same altitude, the brook trout would be shifted northwards by about 330 km. Alternately there might be a combined altitudinal and latitudinal shift. The end result would be a significant shrinkage of habitat in the south, and presumably an expansion in the north.

4. **Pop-offs and squeeze-outs of environments**. Some environments might be lost altogether. Higher mountains have several altitudinally arranged life zones, each adapted to the ambient temperature. As climates warm, the life zones will be displaced upwards. Those closest to the peak may be "popped-off", e.g., oak or pine forests on tropical mountains and alpine tundra from boreal mountains. Given time, mobility of biota and a series of adjacent peaks in a mountain range, species may be able to migrate polewards. But if warming is rapid, species are insufficiently mobile, the peaks are isolated or ranges have gaps in them, then these biota or at least certain species will be lost. Mlot (1991) provided an example of alpine popoff in action. The endangered Uncompahgre Fritillary, *Bolaria acrocnema*, lives at high altitudes on cool snow-moistened peaks in the San Juan Mountains of western Colorado. Hot dry summers in the late 1980s drove one of the population, that on Uncompahgre Peak, from 700 in 1982, to 200 in 1988, and 0 in 1991. Similar effects may occur in seamounts, guyots and fishing banks, as layers of seawater warm. Rising sea level will cause the disappearance of land biota of low lying islands such as atolls and low-lying coastal areas, and possibly marine biota on those coral reefs which are slow-growing, the poleward reefs. The greatest popoff effect may occur in Arctic and Subantarctic environments. Climatic warming is expected to be greatest toward the poles. It is possible that tundra and other northern life zones, with their species, will seriously degrade or even disappear. Such impacts are within the realm of possibility, there are Neogene (Beaufort Formation) fossil tree trunks in the Canadian Arctic Archipelago where today only tundra exists.

An immense aquatic squeeze-out effect can be predicted. Cooler water is denser than warm water, reaching a maximum density at 4°C. The cooled water sinks below the warmer water. Lakes often become stratified into a warm upper epilimnion and a cool, lower hypolimnion, with a zone of rapid change of temperature in between called the thermocline. The cool hypolimnion often has a different flora, fish and invertebrate fauna than the warm upper layer. Turnover events are required to import oxygen from the upper layers of a lake, while the epilimnion relies on those events to replace lost nutrients. If the epilimnion remains above 4°C throughout winter, turnover would no longer occur. Mixing of lake waters and their dissolved nutrients would then depend solely on currents generated by wind and the Earth's rotation. If lake layers remain discreet, even these forces might have no effect.

The epilimnetic nutrient supply and the oxygen reserve of the hypolimnion could become severely limited (Boyce et al. 1989). The degree of loss will depend on the amount of winter warming, depth of the lake, wind-generated lake circulation, and other factors. Squeeze-out took place following deglaciation in North America and Europe, extirpating southern populations of some species, leaving a few southern isolated populations of other species in deeper cooler lakes.



A similar layering of water occurs in the oceans, sometimes complicated by layers of differing salinity - salinity also affects sea water density. The polar regions generate huge masses of oxygenated 4°C water which sink down from the surface and move gradually toward the equator, slowly warming through mixing and release of heat from the Earth's core. Thus, over vast areas of the World Ocean basin, there are faunas adapted to cool water of a rather constant temperature. Polar warming could reduce the volume and thickness of these vast slow ocean currents. Warming will be accelerated if polar sea ice is reduced, because then solar energy, previously reflected back into space, will be absorbed by the sea water. Warming or reduction in thickness of the cold bottom water layer or its disappearance in some areas could squeeze-out, reduce or decimate stenothermal deepsea faunas - faunas that we are just now beginning to appreciate are much richer in species than we had previously thought. Reduction in the velocity of flow might result in stagnation and lower oxygen values. Reduction in the volume of cold sea water sinking at the poles, will also slow down one of the "motors" than drive ocean currents of the world. The effects of the latter are difficult to predict and will be complicated by increased wind-induced surface currents, as the polar sea ice shrinks in area.

5. **Predator, competitor, parasite, disease balance.** Increased susceptibility to predation, competition, parasitism or disease incidence may result from climatic change and impact the populations or survival of a species. Stressed organisms, for example, are generally less resistant to disease, less able to escape predators. Crossman (1991) expressed concern that southern fish species may move northwards and impact on native species. Mandrak's (1989) analysis suggested that it was likely that 27 warmwater species would invade the Great Lakes and that this would dramatically alter the present Great Lakes fish communities.

6. **Symbionts.** The survival of thousands of species depends on symbiotic relationships. Many vascular plants depend on pollinating insects, reef building corals on zooxanthellae - tiny algae in their tissues, clown fishes on sea anemones, termites and mammals on intestinal bacteria, 80% of seed plants on mycorrhizal fungi which transmit nutrients to their roots, etc. Disturbance or loss of one of these symbiotic partners can cause serious consequences to the survival of the other partner.

CASCADE EFFECTS

Some of the direct or indirect effects will lead only to losses of individual species, one by one. But cascade effects will result when keystone forest, coral and other species that provide shelter, food or other resources to several dependent species are lost. The average plant, according to Peter Raven of the Missouri Botanical Garden, supports 18 animal species. Data from the biological inventory of Canada (Mosquin and McAllister, 1991, in preparation) suggests a ratio of 22 animal to 1 plant species. Myers (1984) gave rates of 20 to 40 animal species for each plant, dependent on those plants for their survival. McAllister (1991) estimated that the 500 species of reef building corals supported about 4,000 species of fishes, a ratio of 8 fish species per coral species.

In the cascade effect, the loss of one or a few species may lead to the secondary loss of several others. Those secondary losses may result in tertiary losses and so on. Such effects can be computer modelled or are subject to experimental testing by teams of ecologists and systematists. The clearcutting of natural forests and the introduction of modern agro-chemical-mechanical farming on the tallgrass prairies have constituted large-scale experiments.

Data from the reverse process, recolonization of islands after volcanic events or the intentional application of pesticides, could be reanalysed to test for a snowball effect, where species might be expected to increase logarithmically, initial colonizers providing habitat or resources for subsequent colonizers, with a limiting factor for the rate of dispersal. Biodiversity is controlled by the rates of colonization and survival, and survival is moderated by habitat - itself moderated by the number of species.

Of course there are other fundamental impacts as the loss of biodiversity begins to affect other primary ecological functions. These functions (Mosquin and McAllister, in preparation) include: oxygen production, locking up carbon dioxide, soil creation, erosion protection, hydrological cycle moderation, etc. Obviously when this degree of impact occurs on a wide regional scale, on top of the cascade effects, the results are more difficult to predict.

The interaction between individual anthropogenic impacts such as warming, desiccation, and pollution, has been insufficiently studied. Parsons (1989) proposed that the metabolic response to one stress might curtail the potential to adaptation to a second stress. He stated that even partial genetic associations of

pollutants with metabolic rates would exacerbate the effects of temperature change. At global and regional levels there are a number of concurrent human impacts including climate warming, changes in precipitation, increases in UV radiation and levels of toxic substances, rising sea level, habitat destruction. Studies are needed to determine whether these impacts will be cumulative or synergistic. Practical robust working models and theories on such stresses, based on laboratory and field data, are needed. The risk is so great that general trends, rather than details on combinations and small-scale variation, should be emphasized.

One can conclude that global warming will impact biodiversity in complex and highly unpredictable ways. Indirect, pop-off, squeeze-out and cascade effects and the loss of ecological services may accelerate the rates of extinction predicated on direct thermal lethal effects.

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The rainforests of Australia

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INTRODUCTION

Biologically speaking, rainforests are the most diverse areas on earth, yet their survival is in delicate balance, sensitive to even small change. They are 'closed forests', ecosystems which require a perfect balance created by the development of all their components over millions of years. With the recent "greening" of the planet, rainforests have become common knowledge, or have they? The rainforests of Australia seldom hit headline news, such that some people are not aware of their existence, let alone their preservation. However, the "Wet Tropics of Queensland" in northern Australia, were included on the World Heritage list in December 1988. This area extends over 900,000 hectares in a narrow band comprising various types of tropical rainforest and associated vegetation, including national parks, state forests, timber reserves, aboriginal community owned land and privately owned freehold land.

HISTORY & ORIGIN OF RAINFORESTS

After Australia's eventual total continental isolation thirty million years ago, the country's biota has evolved uniquely from its initial connections with the one supercontinent Pangaea and then the Great Southern Continent of Gondwana (White 1988). Through early links to India, South America and Antarctica, angiosperms migrated and developed, covering much of the continent in rainforest for most of the Tertiary Period. Today, only isolated patches of these rainforests survive. Those remaining are living relics of ancient flora and fauna, that reflect four major stages of the earth's evolution.

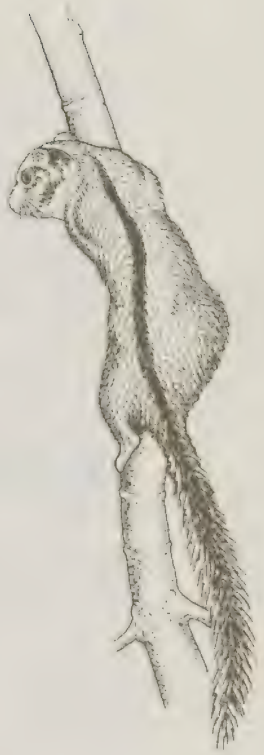
1) The forests contain many primitive flowering plants that give clues as to the origin, early evolution and migration of the angiosperms 120 million years ago (Australian Heritage Commission [AHC] 1986).

2) They contain flora, from which the majority of the drier sclerophyll flora evolved after Australia's isolation and the onset of an increasingly arid climate about 35 million years ago.

3) The forests have preserved records of the mixing of two continental biotas after the Australian and Asian plates collided 15 million years ago, and brought together flora and fauna that had been separated for 80 million years.

4) They include living records of the effects on tropical vegetation of the Pleistocene glacial period, which occurred between 2 million and 10,000 years ago with information on the evolutionary processes of development and extinction of many species.

These historical climatic changes usually resulting in an increase in aridity have altered much of the forests, leaving only 1% of the total area of the continent covered with forests (White 1988). The majority of this deforestation took place during the glacial period when annual rainfall was decreased significantly.

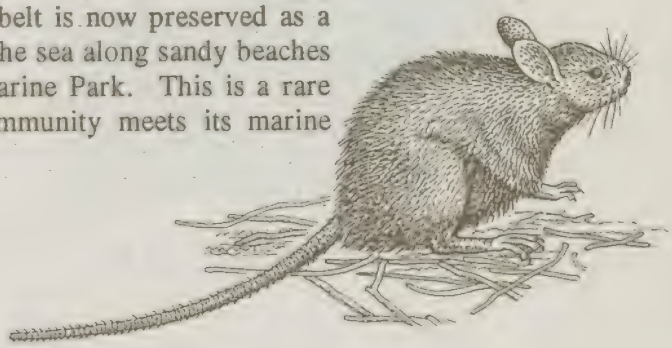


HUMAN IMPACTS

Since the arrival of Europeans in Australia two hundred years ago, with their insatiable desire for arable land and timber, only about a quarter of the forests have survived and only approximately 40% being of that area is still virgin, unlogged forest (AHC 1986). In coastal northern Queensland, clearing of land was predominantly for sugar cane and cattle farming, but increasingly this land is being used for tourist resorts. There are now production quotas on sugar growing and, in many wet areas, cattle farming was unsuccessful and has been abandoned. In some places, exotic tropical fruit orchards are being planted where only grasses have been growing this century (sugar cane is a grass). To produce fruit the growers often "improve" soil quality by extensive mulching and the constantly adding fertilisers. Fruit trees shade the soil and produce associated microclimates closer to those of the rainforests.

The majority of the remaining rainforest in Australia is restricted to northern Queensland, in areas where the mean-annual rainfall is between 4000 and 1200 mm (AHC 1986), and in small pockets stretching up the east coast from Townsville northward to Cooktown, and extend inland to the McDowell range to the west. The rainforests of northern Queensland contain Australia's highest levels of species diversity. This relatively small area represents only 0.1% of the country, yet the variation of flora and fauna displayed here is vast.

The largest of the pockets of rainforest is the Daintree Rainforest around Cape Tribulation, 140 km north of Cairns. The 16,959 ha of forest stretch along the coast between the Daintree and Bloomfield Rivers. The area was named by Captain Cook, whose ship H.M.S. *Endeavour* was holed on the reef in 1770. He named the Cape after all the trials and tribulations it caused him and his crew. This rainforest belt is now preserved as a national park. The area is totally unique, as rainforest meets the sea along sandy beaches and rocky headlands, joining with the Great Barrier Reef Marine Park. This is a rare situation where the most biologically diverse terrestrial community meets its marine counterpart.



FOREST DIVERSITY

The northern Queensland rainforests contain 25% of all rainforest plant genera, 78% of them monotypic. There are 516 genera, in 119 families and 1160 species of higher plants. They also have the highest concentration of primitive flowering plants in the world (13 out of the 19 families of the primitive angiosperms are found here; two of them endemic). A large number of the plants have restricted distribution, displaying distinct altitudinal and or habitat zonation. The distribution of the majority of species is thought to be localised in refugia that survived past climatic change (AHC 1986).

In the rainforests of Australia, the majority of the plants are classified as uncommon as only 6% of the higher plant species occur throughout the forests (AHC 1986). There are high numbers of monotypic genera and at least 25 species of animals in these forests are endangered. These forests contain the only rainforest *Drosera* species in the world, and both the largest and smallest cycads. Altogether, 36 genera and 435 species are restricted to these forests. The fauna contained here are also the most diverse in Australia. Within these rainforests are found 30% of the marsupial species, 23% of the reptile species, 60% of the bat species, 30% of the frog species, 62% of the butterfly species and 18% of the bird species. A total of 54 species of vertebrate animals are endemic to this area (AHC 1986). In contrast to this richness, the rainforests soils are notoriously lacking in nutrients. The majority of the forest surface consists of tropical red and yellow earths, which are typically acidic and low in nutrients. High concentrations of iron and aluminium form insoluble compounds with phosphorous, thereby decreasing the availability of phosphorous to plants. Rainforest plants receive most of their nutrients directly from rainfall, and little from the poor quality soil, particularly after it is exposed to tropical sun. The arid centre of Australia was, at least in part, covered with rainforest until climatic change reduced it to its present desert state.

CONSERVATION

Although there has been little investigation into the regeneration of virgin forest to date, it is thought to happen by a cyclic regrowth (Wilson 1988). Reforestation, is severely limited by the fragility of most seeds that germinate within a few weeks, thus limiting their ability to disperse to distant sites favourable for growth. Most seeds die, especially those that are dispersed to the hot sterile soil of the clearings. Others that become small seedlings in rainforests are destroyed by introduced wild pigs that inhabit the area. Once land has been totally cleared to pasture this problem is intensified.

In the Cape Tribulation National Park a small reforestation program is underway, linked to a research station located there. The project involves the removal of grasses and planting of native flora, both from seed and by transplanting established seedlings. In the tropical conditions, without a natural protective canopy, it is hard work. On such a small scale it may be considered optimistic to try and regenerate in 60 years what had previously stood for 60 million. If left to recover, it is estimated that some logged sites may naturally regrow to something of their original state in several hundred years. On a national scale, further steps are being taken. A Wet Tropics Management Authority has been established to carry out "...Australia's international duty for the protection, conservation, presentation, rehabilitation and transmission to future generations of the Wet Tropics of Queensland World Heritage Area...". Plans are currently being prepared by the Queensland Government for the implementation of this. These are to have a statutory basis, resulting in this area finally being protected by law.

The current plight of the world's rainforests has developed into a major environmental issue, with public concern focused on the Amazon basin. Brazil has a far greater expanse of tropical rainforest than any other nation on earth, and views it as a valuable, but wasted asset. For at least twenty years, Brazil has exploited these forests consequently destroying them. Many of the demands for hardwoods and other specialist timbers are currently satisfied by Brazil's rainforests. There has also been mass destruction of the forests to create pasture lands for cattle (Myers 1979). Some of the resulting glut of meat has been used for the fast-food industry in the United States, Canada and elsewhere instead of being used to feed Brazil's people.

With the building of the Transamazon Highway in 1970, some of the rainforest was cleared for agricultural development by Brazil's famine-stricken north-eastern people. The poor quality soil has caused many of the farmers to use slash-and-burn techniques, resulting in little relief from their problems and more deforestation. Only 7% of the planned settlement can be termed successful (Myers 1979).

There is growing public outcry over the continuing destruction rainforests that have stood for millions of years yet are disappearing daily. Approximately 40% of the land that can support tropical rainforest is now "supporting" something else (Wilson 1988), primarily due to human action. At the present time, under 5% of the remaining forests are protected within parks and reserves, and even these are vulnerable to political and economic pressures. Slowly we are starting to recognise our responsibility to this planet and it's future and become aware that our technology may eventually destroy us. We are, after all, just another species. How dare we destroy forest ecosystems that preceded our existence by 58 million years! Throughout the ages, the Earth has been in the process of co-existence, with a balance of give and take. Those unable to adjust have become extinct. We have expected millions of species to adapt to us but, will this continue until one day there is nothing left to adapt?

Canadian Biodiversity 2(2)

Canadian Museum of Nature

In the question of preservation of species, the destruction of the even small rainforest areas may pose threats, due to the localised distribution of so many species and how practical it is to preserve all remaining species is debatable. Ironically, the question of how many species have actually existed will probably never be answered, as it is impossible to estimate the extent of the damage already caused by the transformation of the land. However, even rough estimates are high. As the size of remaining forests is reduced the fragile habitat is disturbed leading to further extinctions. There is also increasing concern that excessive deforestation could be disrupting the hydrological cycle causing an irreversible drying trend on earth and the build up of greenhouse effect as carbon dioxide is released into the atmosphere.

A project that attempts to marry Brazil's desire for economic development with an international desire to save large parts of the world's largest rainforest, (for its biological wealth and presumed role in maintaining the world's weather) was launched by the German Chancellor Helmut Kohl, in the summer of 1990. At a Group of Seven summit in Houston, he said they should start a plan to save the world's rainforests starting with the Brazilian Amazon (Pearce 1992). Since then the World Bank has set up a rainforest trust under the umbrella of the Global Environmental Facility, and by December 1991 had cash commitments of $250 million, the amount the bank said it needed to start the project. The project aims to, 1) "conserve biodiversity and indigenous areas" which will be done largely by creating national parks and reserves, 2) "consolidate environmental policy changes and strengthen implementing institutions", a goal that is to be to be achieved by economic and ecological zoning of the forests, 3) develop scientific knowledge and applied technologies for sustainable development, and 4) "build support for environmentally benign development", which Pearce (1992) points out could mean anything. The project is a model for saving other forests and other crucial ecosystems and as the United Nations Earth Summit in Rio approached, it has been a critical test of the political will to solve global environmental problems.

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Parks, Protected Areas and the Human Future: THE CARACAS DECLARATION

WE, over fifteen hundred leaders and participants deeply committed to world conservation, brought together by the World Conservation Union for the Fourth World Congress on National Parks and Protected Areas in Caracas, Venezuela, between 10 and 21 February 1992, ADOPT this Declaration of our belief in the vital importance of well-managed national parks and protected areas to all people.

WE RECOGNIZE THAT:

- nature has intrinsic worth and warrants respect regardless of its usefulness to humanity;
- the future of human societies depends upon people living in peace among themselves, and in harmony within nature;
- development depends on the maintenance of the diversity and productivity of life on Earth;
- this natural wealth is being eroded at an unprecedented rate, because of the rapid growth in human numbers, the uneven and often excessive consumption of natural resources, mistaken and socially harmful styles of development, global pollution and defective economic regimes, so that the future of humanity is now threatened;
- this threat will not be averted until these problems have been redressed, the economies of many countries have been strengthened, and poverty has been conquered through processes of sustainable development;
- many people must modify their styles of living and the world community must adopt new and equitable styles of development, based on the care and sustainable use of the environment, and the safeguarding of global life-supporting systems;

WE CONSIDER THAT the establishment and effective management of networks of national parks and other areas in which critical natural habitats, fauna and flora are protected must have high priority and must be carried out in a manner sensitive to the needs and concerns of local people. These areas are of crucial, and growing, importance because:

- they safeguard many of the world's outstanding areas of living richness, natural beauty and cultural significance, are a source of inspiration and are an irreplaceable asset of the countries to which they belong;

- they help to maintain the diversity of ecosystems, species, genetic varieties and ecological processes (including the regulation of water flow and climate) which are vital for the support of all life on Earth and for the improvement of human social and economic conditions;

- they protect genetic varieties and species, which are vital in meeting human needs, for example in agriculture and medicine, and are the basis for human social and cultural adaptation in an uncertain and changing world;

- they may be home to communities of people with traditional cultures and irreplaceable knowledge of nature;

- they may contain landscapes which reflect a long history of interaction between people and their environment;

- they have immense scientific, educational, cultural, recreational and spiritual value;

- they provide major direct and indirect benefits to local and national economies and models for sustainable conservation which may be applied elsewhere in the world.

ACCORDINGLY, and bearing in mind the message of *Caring for the Earth: A Strategy for Sustainable Living*, the *Global Biodiversity Strategy* launched at this Congress, and the earlier messages of the World Conservation Strategy, the World Charter for Nature and the World Commission on Environment and Development, WE, the PARTICIPANTS OF THE CARACAS CONGRESS;

1. REAFFIRM the responsibility of humanity to safeguard the living world;

2. EMPHASIZE the spiritual, social, economic, scientific and cultural importance of national parks and other kinds of protected area;

3. STRESS that the conservation of global biological diversity and the achievement of sustainable development depends upon effective and vigorous international action to reform the world's economic and trading systems, and to halt the global pollution that threatens to bring about climate change;

4. STRONGLY URGE all governments, regional and local authorities and international institutions to include protected areas as integral elements in development policies, programmes, plans and projects;

5. ENCOURAGE communities, non-governmental organizations, and private sector institutions to participate actively in the establishment and management of national parks and protected areas;

6. URGE all governments, local authorities, international institutions and non-governmental organizations to inform and educate all sectors of society about the importance of protected areas, and the economic, social and environmental benefits they provide, and so make the public active partners and supporters in their protection;

7. INSIST THAT industry (including tourism, agriculture, forestry and the extraction of oil and minerals) must adopt the highest standards of environmental protection and eliminate damaging impacts on protected areas;

8. STRONGLY URGE industry, especially multi-national corporations, and governments, to ensure that any exploitation of biodiversity conforms with rigorous controls established by the sovereign State concerned.

9. EMPHASIZE the vital role of environmental education and urge all governments to strengthen their programmes, especially in and relating to national parks and protected areas, constituting appropriate national organizations to develop and coordinate this process.

10. EMPHASIZE that although national parks and other protected areas are of special importance, all lands and seas should be managed so as to maintain (or restore) the highest environmental quality.

11. STRESS the need for international cooperation and assistance to place the latest knowledge and best available technology at the disposal of all governments and especially their protected area managers.

TO THESE ENDS WE STRONGLY URGE ALL GOVERNMENT AND APPROPRIATE NATIONAL AND INTERNATIONAL BODIES:

1. To take urgent action to consolidate and enlarge national systems of well-managed protected areas with buffer zones and corridors, so that by the year 2000 they safeguard the full representative range of land, freshwater, coastal and marine ecosystems of each country and allow these ecosystems space to adapt to climate change.

2. To ensure that the environmental and economic benefits which protected areas provide are fully recognized in national development strategies and national accounting systems.

3. To support the development of national protected area policies which are sensitive to customs and traditions, safeguard the interests of indigenous people, take full account of the roles and interests of both men and women, and respect the interests of children of this and future generations.

4. To ensure that effective international, national, regional and local administrative, legal, accounting and financial mechanisms for supporting protected areas are established as a matter of priority and regularly reviewed.

5. To allocate adequate financial and other resources so that, once designated, protected areas are managed effectively, to achieve their intended objectives.

6. To strengthen environmental education, and to provide training what will improve professionalism in the management of protected areas.

7. To facilitate the establishment of effective and efficient networks of NGOs cooperating at a local, national and international level to further national park and protected area objectives.

8. To recognize the significance of demographic change and its consequences for the survival of biological diversity and to take appropriate actions to reduce this threat.

9. To foster publically funded scientific research and monitoring what will improve the planning and management of protected areas, and to use such areas as sites for studies that will improve understanding of the environment.

10. To develop mechanisms that will allow all sectors of society, especially long-standing local populations, to be partners in the planning, establishment, and management of protected areas, and will ensure they share equitably in the associated costs and benefits.

11. To participate actively in global and regional Conventions and other legal instruments, action programmes, and procedures to promote protected terrestrial, coastal and marine areas and the conservation of biological diversity.

12. To work energetically to safeguard the world's tropical forests, particularly those of Amazonia which are reservoirs of outstanding biological diversity and under severe pressure.

13. To strengthen international technical and financial cooperation that will assist developing countries to establish and manage protected areas and to safeguard biological diversity.

14. To cooperate to safeguard species, ecosystems and landscapes that extend across national borders and therefore require protection through the collaboration of neighbouring countries.

RECOGNIZING that action to safeguard the living riches and natural beauty of the Earth depends on the commitment of all people, WE PLEDGE OURSELVES to work wholeheartedly to implement the provisions of this Declaration.

EMPHASIZING that the establishment and maintenance of protected areas is essential to sustaining human society and conserving global biological diversity, WE INVITE THE PRESIDENT OF THE REPUBLIC OF VENEZUELA to convey this Declaration to the Earth Summit, to be held at Rio de Janeiro, Brazil, in June 1992 with the purpose of ensuring that its conclusions are incorporated in Agenda 21, the agreed world action plan for the next century.

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VIEWS

Resolution Concerning Study of Biodiversity of Terrestrial Arthropods

"**Whereas** maintenance and wise use of biodiversity is acknowledged generally to be essential to the normal functioning of life-sustaining ecosystems; and

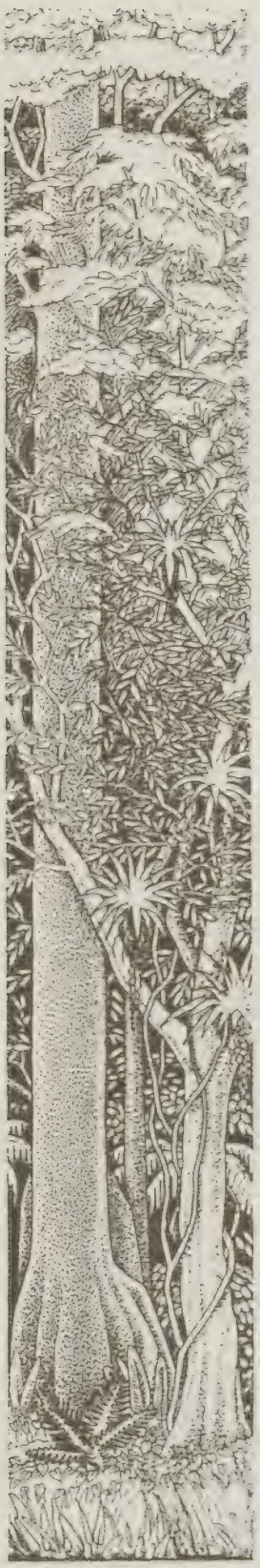
Whereas understanding of biodiversity is essential to manage, use wisely and protect life-sustaining ecosystems; and

Whereas terrestrial arthropods comprise millions of species, an overwhelming component of biodiversity; and

Whereas the Entomological Society of Canada is concerned with development and the means of development of knowledge of terrestrial arthropods; and

Whereas systematic entomologists contribute to the understanding of biodiversity and thus make management, wise use and protection through discovery, description and classification of terrestrial arthropods; and

Whereas the Canadian contribution to the study of diversity of terrestrial arthropods is being weakened through reduction in number of systematists in institutions of higher learning and in institutions of the federal government with mandates and resposibilities for knowledge of biodiversity and ecosystems; and



Whereas such reductions constitute failure to fulfill responsibilities;

Be it resolved that the Entomological Society of Canada urges government ministries and institutions of higher learning responsible for such failure, to reconsider the negative actions that have led to reduction of support for research in systematic entomology; and

Be it further resolved that the Entomological Society of Canada urges that action be taken to prevent further erosion in said organizations with capabilities in systematic entomology; and

Be it further resolved that the Entomological Society of Canada urge the federal government in conjunction with institutions of higher learning to undertake development of a plan to increase the Canadian contribution to study of terrestrial arthropod biodiversity."

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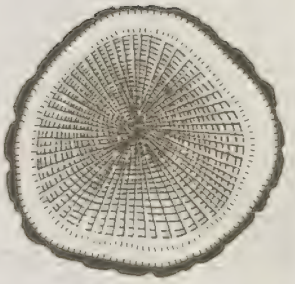
Acting locally to protect forests in the Philippines

Aris R. Ilagan

Tropical Storm Thelma was the most recent disaster to strike the Philippines. On November 5, high waves and flooding brought on by the storm trapped and killed over 7,000 residents of an economically-depressed area of Ormoc City. Ormoc City is located on the island of Leyte in the central part of the Philippines. Local government officials were quick to lay blame for the flash floods exclusively on the illegal logging activities which have been carried out unabated on the island. Some claim that the widespread destruction of forests caused by illegal logging is now starting to take its toll in human lives.

Illegal logging in the Philippines has been linked to military personnel and police - who are, ironically, those designated specifically by the government Department of Environment and Natural Resources to protect forest areas - and to powerful government officials and politicians. In the late 1970's, many influential people within these circles began to tap into the country's forest resources as a lucrative source of personal income. Using sophisticated timber-cutting equipment and well-established connections in the government bureaucracy, illegal logging ventures have increased at an alarming rate in the past ten years. Currently, only about 25% of the Philippines' once rich forest cover is still left standing.

A helicopter survey over Isabela and Cagayan provinces in the northern Philippines draws a disheartening picture of vast mountain ranges now completely denuded of trees. In the country's southernmost region of Mindanao, the same problem exists in the provinces of Sultan Kudarat, Cagayan de Oro and Cotabato. Palawan, an island located in the western Visayas region and known for its bountiful forest and sea resources, is the most recent target of logging operations.

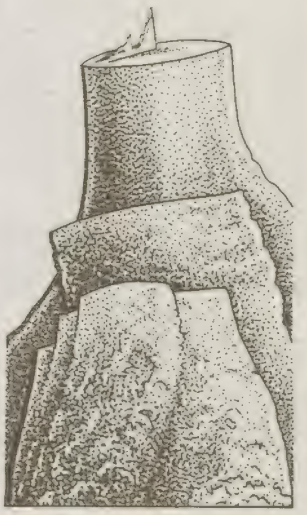


Despite repeated media exposés and public outcry, logging activities are continuing throughout the Philippines at a destructive rate. The implementation of measures to counter deforestation has been a fiasco, largely due to the lack of real commitment on the part of government officials and politicians. Reforestation projects undertaken by the Department of Environment and Natual Resources have proceeded at a snail's pace. Many have disintegrated immediatley after the official "first-tree" planting ceremonies reported in the press. In 1987, only 40,000 hectares of forestland were replanted. Meanwhile, it is estimated that 67 million hectares require immediate reforestation.

Deforestation has harmed arable land, 75% of which is now considered to be highly vulnerable to soil erosion. According to government statistics, Philippine agriculture loses one billion cubic metres of precious topsoil to erosion annually. Indifference of the national leadership to forest conservation has prompted the civilian sector to act against rapid depletion of forests. Unknown to many, non-government organizations (NGO's) have been silently working to save the country's forests for future generations. Their concerted efforts have ensured that environmental awareness is now everyone's concern.

Despite the absence of government support, NGO's have thrived, conducting educational campaigns on forest protection for people in urban areas. They are also assisting rural inhabitants, particularly indigenous peoples living in upland areas, to undertake sustainable and community-based management of local resources. The Philippines' many minority indigenous groups are often the worst affected by deforestation because they tend to live in mountainous areas where soils are most susceptible to erosion once the forest is logged. Of the estimated 18 million upland dwellers in the country's forest areas, more than 50% belong to indigenous communities.

The Philippine Association for Intercultural Development (PAFID) is one NGO which has been active in advocating greater environmental awareness and assisting indigenous groups to obtain rights to their own lands and resources. PAFID believes that granting of land tenure to local communities is a fundamental requirement for conservation, protection and proper utilization of the forest. It has been involved in a campaign for the development of a long-term land stewardship agreement between tribal communities and the Philippine government. Land stewardship is a stop-gap measure which hands over to indigenous groups the rights to manage communal resources for a specified number of years. Legislation granting permanent ancestral land rights is still pending before the Philippine Congress.



After years of court proceedings and continual pressure applied on the government by NGO's such as PAFID, the Mangyan tribal communities on Mindoro Island succeeded in obtaining a forest stewardship agreement. The agreement cedes control over forest resources to the Mangyan tribal organizations, allowing them to safeguard their lands

against illegal logging. PAFID also helped the Negrito tribes in the central province of Aklan to organize and to lobby the Philippine government. These communities had suffered years of mistreatment at the hands of loggers who were illegally cutting down their mahogany trees - with the tacit consent of government officials. The Negritos have been successful in acquiring long-term tenure over their ancestral lands. In addition to community organizing and lobbying, PAFID helps tribal communities acquire skills in upland farming techniques which protect the environment, for example agroforestry and soil and water conservation.

Among the NGO's that are now in the forefront of environmental preservation in the Philippines is the HARIBON Foundation. HARIBON's work is devoted to the conservation of natural resources and indigenous culture. The foundation spearheaded the formation of the largest coalition of environmental groups in the country, now called Green Forum Philippines. The Executive Director of HARIBON, Maximo T. Kalaw Jr., says, "there is a wealth of possibilities NGO's can explore as they network beyond the confines of government and narrow development paths". In a country where the poor majority have long been drowned out by the powerful few, NGO's are helping them to make their voices heard.

The author of this article is Aris R. Ilagan, a Filipino writer who has written frequently about such issues as government corruption and illegal economic activities in his native country. *The preparation of this article was made possible by the support of the Philippine Development Assistance Program (PDAP) and the Canadian International Development Agency (CIDA).*

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NEWS

Biotechnology Corner
Biodiversity's potential for biotechnology

Antifreezes for crops and engines?

Don E. McAllister
Canadian Centre for Biodiversity
Canadian Museum of Nature
P.O. Box 3443, Statio D
Ottawa, Ontario K1P 6P4, Canada

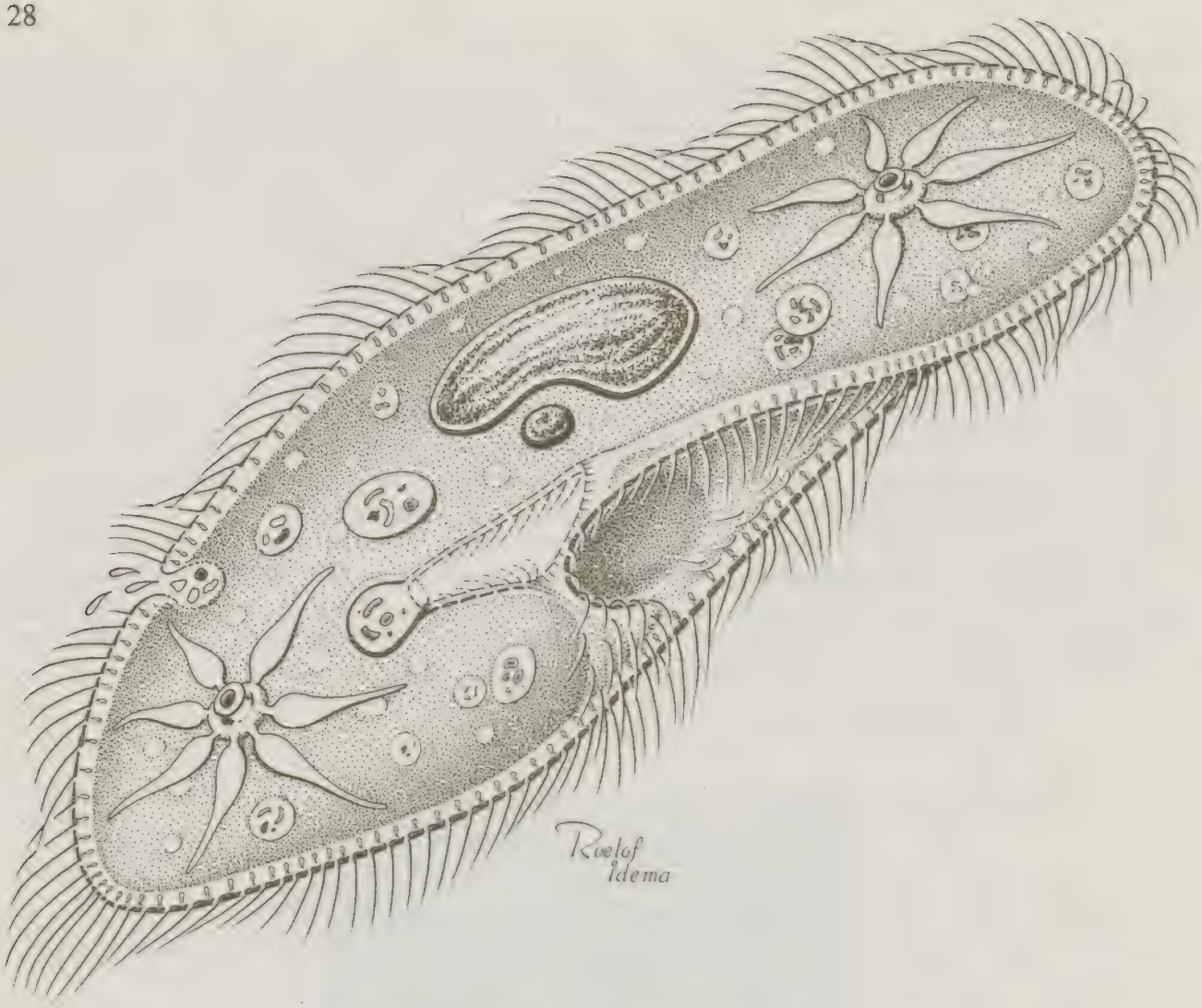
Recent research has shown that the resistance of certain plants to chilling is promoted by the presence of fatty acid compounds. Unsaturated fatty acids in plants such as spinach and the mustard family plant, *Arabidopsis*, make them more resistant to cold. The fatty acids are contained in the chlorophyll-containing bodies called chlorplasts that harness the sun's energy for the plant. When the genes that produce the fatty acids are transferred to chill-sensitive species, such as tobacco (*Nicotiana tabacum* var. *Samsum*), then they become more cold resistant. This promising work was carried out by Norio Murata and his colleagues from the National Institute for Basic Biology and the Kirin Brewery Company in Japan. It is reported in the 23 April 1992 issue of *Nature* journal (Volume 356, pp. 710-714).

If cold tolerant or frost resistant genes can be transferred to commercial crop plants, the benefits could be great. Crops could be grown further north or at higher altitudes. The growing season could be lengthened to produce higher yields.

Certain plant species might possess genes for superior cold resistance. Species such as the Yellow Avalanche Lily (see above photo) and the Prairie Crocus (*Pulsatilla ludoviciana*) are able to tolerate freezing temperatures in spring when they often push up through the snow. Could genes from such species enable wheat and rye to be grown further north than at present? The reverse phenomena should not be ignored, genetic engineering could increase resistance to heat and drought.

Other anti-freeze compounds might find uses as products in engines. A number of Arctic and Antarctic fish species have antifreeze compounds in the blood. The freezing point of sea water is below that of freshwater or that of the blood of many species. Anti-freeze compounds like serum glucoproteins in the blood of notothenioids permit them to carry on a normal life in polar waters as cool as -1.9°C without freezing solid. The fish antifreezes must be sufficiently fluid (low viscosity) at ambient temperatures to flow through the fishes' tiny capillaries. Would study of these compounds permit us to develop superior antifreezes for car radiators, heat pumps, etc.? Could the relevant genes be transferred to plants? Does the blood of deepsea fishes or of invertebrates which typically live under temperatures of 4°C and extremely high pressures, contain compounds of interest to industry?

*Yellow Avalanche lilies, **Erythronium grandiflorum**, grow at or above the treeline in the Rocky Mountains. As shown in the above photo, these lilies are able to push through snow in the spring to take full advantage of the short growing season. (Photo by Don E. McAllister)*



The genus ***Paramecium*** *is classified as follows - Kingdom Protoctista, Phylum Ciliophora, Class Oligohymenophorea. Species of this genus exhibit some of the most elaborate internal structure of all unicellular organisms. Ecological functions of this group, like that of many protoctists, include conversion of vast amounts of bacterica and organic detritus to larger (60-300 μ) organisms that are then ingested by larger animals such as crustacea and insect larvae. These common inhabitants of almost any body of standing water are characterised by numerous cilia anchored in a relatively rigid outer membrane, the pellicle, and by at least two nuclei, the larger macronucleus that is used for metabolism and the smaller micronucleus (or nuclei) used for reproduction. Bacteria and organic particles are swept by ciliary currents into the cytostome, or mouth. After a physically well-defined and enzymatically complex digestion, waste is ejected from an anal opening. Contractile vacuoles are responsible for osmotic regulation. Wavelike motion of groups of cilia result in movement of 60 mm/hr, not impressive as an absolute figure, but when compared to body length, at 4 body lengths/s, is comparable to the speed of a subsonic aircraft.*

Biodiversity Facts

Blue Biodiversity

Many people know that fresh blueberries or blueberry pie filling can produce a lasting stain on a garment. They may not know that a significant part of the blueberry crop produced in New Brunswick is used as a coloring agent in many blue printing inks as well as in other products. The cover of *Canadian Biodiversity* uses blueberry-based ink. Unlike a number of other coloring agents, blueberry blue is non-toxic.

Green Biodiversity

What is Canada's biodiversity worth in monetary terms - greenbacks? A report being prepared on Canada's biodiversity, the *Canada Country Study of Biodiversity*, suggests that "raw" biodiversity is worth $70 billion per year. By raw values is meant the value before much processing is carried out, e.g. values based on the wharf price of fish, the farm-gate price of grains, and the price of lumber. Other values include outdoors tourism, angling, pollination of crops by insects (worth about a billion dollars a year). Without yeast bread wouldn't rise and beer wouldn't brew, so the baking and brewing industries depend on the fermenting activities of tiny fungi.

But the values of biodiversity extend beyond those currently measured in monetary terms, and some values are not appropriately measured in money. Biodiversity provides a number of ecological services. These include the creation of soil, recycling nutrients, fixing nitrogen in soils, production of oxygen, banking of carbon (limiting the greenhouse effect), moderating the hydrological cycle, providing habitat for other species in three-dimensional structures such as kelp and trees, and over a dozen others. Preliminary estimates have been made for some of these processes, others have not yet been evaluated, on yet others it may be difficult or impossible to place a monetary value. These processes contribute to sustaining the planet, other life forms and humankind; it is difficult to put a value on processes of such important. Nor can spiritual values and joy be easily measured. What is a child's smile worth when a chickadee takes a sunflower seed from her or his hand? [Copies of the draft Country Study are available for $35 + $2 mailing and handling + GST from the **Canadian Centre for Biodiversity, Canadian Museum of Nature**.]

100,000 Commercial Chemicals in Europe

A recent 8-volume publication lists 100,000 chemicals that can be marketted and are exempt from the European Community regulations prior to launching on the market. The chemicals are listed by chemical name, molecular formula, if appropriate, and have a Chemical Abstract Service number. The inventory does not, of course, cover those chemicals subject to licensing. This means that the environment, animals and plants are exposed to selected combinations of man-made chemicals from a roster of well over 100,000 compounds. The publication's title is **European inventory of existing commercial chemical substances**. Published by the Commission of European Communities it is available for $310 in a two-volume paperback, $475 in an 8-volume set, or as a magnetic tape for $1420.

Biodiversity News

1992 Massey Medal awarded to Stuart D. MacDonald

Stuart D. MacDonald was awarded the The Royal Canadian Geographic Society 1992 Massey Medal. The medal is the highest Canadian award for personal achievment in exploration, development or description of geography of Canada. MacDonald was one of the first biologists to carry out systematic research and collecting on the Queen Elizabeth Islands since the explorers visited them. Although an expert on bird ethology or behavior, he was noted for the breadth of his interests and collections. He made observations and collections on botany, marine fishes and invertebrates, and established a biological and meteorological station at the Polar Bear Pass, Bathurst Island, N.W.T. for the Canadian Museum of Nature. This station provided one of the few sites where longterm Arctic biological observations have been carried out in the Canadian Arctic. The stations was built and maintained with slender budgets and cooperation between the museum, the Polar Continental Shelf, and many other organizations. He opened the station to people from many universities and other organizations, and encouraged the participation of women scientists, despite administrative roadblocks. He was the first person to describe the breeding behavior of the rare Ivory Gull. Stuart is well-known for his exquisite photos of Arctic wildlife which reflect his knowledge of behavior, photographic skills, and endless patience. [B. Theresa Aniskowicz, *Canadian Geographic* 112(3): 16-18].

Canada to Support Human Genetic Code Study

The green light has just been given to fund Canadian study of the human genetic code, known collectively as the human genonme. The Human Genome Project, a multi-billion dollar 15-year study to map and sequence the genes on the 46 human chromosones, has been funded by several government, especially the United States. Canada's Science Minister, William Winegard, announced June 2nd, that the Canadian government will contribute $12 million for the first 5 years for Canadian studies of the human genome. Winegard said, "This is a major world program and we certainly can't afford not to be there." Winegard also said the government is looking for a contribution of about $20 million from private biotechnology companies to help Canada's human genome studies. The National Cancer Institute and the Medical Research Council had already committed $5 million each. This would make for an expected combined funding of $42 million. The U.S. government spent about $135 million in 1991 alone. The news releases do not mention funding for any other genomes than the human genome. Study of other genomes promise considerable dividends in, for example, biotechnology, pharmaceuticals, and agriculture. For more information on the Human Genome Project see articles in 1991 by Dr. Phyllis J. McAlpine in *Canadian Biodiversity* 1(3): 31-34 and 1(4): 12-16.

Biodiversity Meetings

■ October 12-16, 1992. **The Regional Environmental Centre for Central and Eastern Europe: 1992 International Symposium on Environmental Contamination in Eastern and Central Europe - A Forum for Technology Transfer.** Budapest, Hungary.
Contact: Dr. Roy Hemdon
Florida State University
Tallahassee, FL 32310-3700
U.S.A.
Tel: (904) 644-5524
Fax: (904) 574-6704

■ October 17-21, 1992. **Eco Ed '92. Education and Communication World Congress on Environment and Development.** Held at Toronto, Ontario, Canada.
Contact: Mr. Chuck Hopkins
Tel: (1-416) 482-9212
Fax: (1-416) 482-9601

■ October 30 - November 2, 1992. **Conservation Genetics and Evolutionary Ecology: Case Study of the Cichlid Fauna of Lake Victoria.** To be held at Stouffer Hotel, Dublin, Ohio.
Contact: Conservation and Genetics Symposium
c/o Doug Warmolts
9990 Riverside Drive, Box 400
Powell, Ohio, U.S.A. 43065-0400
Tel: (614) 645-3400
Fax: (614) 645-3465

■ December 1-3, 1992. **High Institute for Public Health: International Conference on Women and the Environment.**
Alexandria, Egypt.
Contact: Prof. Dr. Samia Galal Saad
Dept. Env. Health, HIPH
165 El-Horriya Ave.
Alexandria, Egypt
Tel: (20-3) 421-5575/6
Fax: (20-3) 421-8436

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Book and Periodical Niche

Mushrooms of Western Canada
By H.M.E. Schalkwijk-Barendsen. 1991. Lone Pine Publishing, Edmonton, Alberta, Canada 414 pp., col. ill. Paper. $19.95. ISBN 0-919433-47-2.

For the first time in the history of Canadian mycology, a comprehensive field guide to the mushrooms of western Canada has been published. Approached by the publisher to prepare a book on mushrooms, the author successfully combined her artistic talent in painting with her enthusiasm for mushroom hunting to provide amateur mycologists and naturalists with an interesting and well documented work on mushrooms.

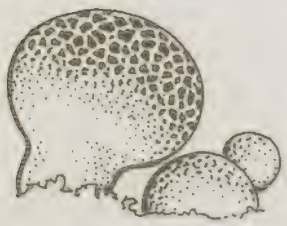
The originality of this publication lies in the description and illustration of a large number of species in an almost pocket size book. This has been achieved by means of concise descriptions and well-painted illustrations. The geographic distribution of the 550 species described covers all of western Canada from the prairie provinces to British Columbia, and the Pacific Northwest regions to Alaska, with a wide range of habitats and variety of climate zones. Although the field guide concentrates on these areas, the

majority of the species have a North American or a cosmopolitan distribution. Therefore this book may be of interest to many naturalists and mycologists in other parts of North America.

General comments on mushrooms, including biology, taxonomy, field identification, and techniques of harvesting are brief and not very informative. An elementary illustrated key to fruiting bodies and a glossary accompanied with very basic line drawings of mushroom characters may not be of help to beginners; and to fully appreciate the value of this book, one must be already knowledgeable in basic mycology and have some previous experience in the identification of mushrooms.

The bulk of the book is divided into three interrelated parts which guide the users through the complete identification process: Keys to family and/or genera, illustrated keys to species and a descriptive section.

Keys to families are rather easy to use and refer directly to illustration keys by a page number. Unfortuantely, keys to gilled mushroom families are entirely based on spore print colour and this considerably reduces their usefulness for direct field identification. Illustration keys contain short descriptions (2-3 lines) of each species, listing the major features required to distinguish between species. Each of the keyed species also refers to a page number which brings the user to a full but concise description with comments by the authors. Throughout the book, common names take precedence over Latin names. Each species of a family or of a section of a family has a reference number which corresponds to a colour illustration appearing on the adjacent or following page, an arrangement which facilitates a quick consultation. Three to eleven species may be represented together on a colour plate, each showing young and mature specimens of the fungal species with an occasional elementary sketch of the species habitat, substrate or associated plant. Some of the plates are overloaded and difficult to consult, and some others display inaccurate colours or forms. Nevertheless, the great majority of then are highly representative of the species illustrated and excellent for the purpose of a field guide.



The taxonomy of mushrooms at the generic and species levels is up-to-date; and the author has done a commendable job of covering almost all of the North American Hymenomycetes and Gasteromycetes families such as a substantial number of Discomycetes and Pyrenomycetes. The Agaricales are particularly well covered, especially the Tricholomataceae and Cortinariaceae families.

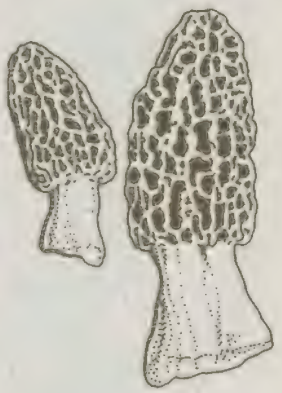
On the whole, this is a very attractive book whose precise and accurate descriptions and coloured illustrations should appeal particularly to mycophiles from Western Canada who have not had such a first-class guide to the mushrooms of their region. While it may not contain sufficient basic information to enable a beginner to sort out the large number of species represented, the reliability and accuracy of the descriptions, the informative illustrations, and the easy-to-use keys should guarantee that this guide will be a best seller for many years to come. The author deserves congratulations for such a significant contribution to the mycological literature.

Kris A. Pirozynski, Paleobiology, Canadian Museum of Nature, Ottawa.

A heritage worth saving
Educational leaflet by the Ministère de l'Environnement, Québec, 1991 (available in French and English).

A new law dealing with threatened and vulnerable species in Quebec was enacted in June 1989. To promote a better understanding of threatened and vulnerable species and their habitats, the Quebec Ministry of Environment subsequently produced a very informative educational leaflet. It is aimed at students and teachers at the senior elementary and first year secondary school levels.

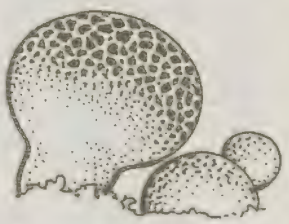
The leaflet is in the form of a single page fold-out, printed on both sides. The information presented helps students to focus on the problem of habitat loss at the local level through the use of a specific example while at the same time providing general facts on threatened species and forests on a broader scale.



The inside of the leaflet consists of a collage of images of a wetland habitat and its surrounding forest. Illustrations and facts are presented that explain the potential uses and values of the site for agriculture, industry, and housing, as compared with its value as a home for wildlife, some of which is rare, and its use for recreation and nature study. Students are asked to work in teams in evaluating the conflicting potential uses and present arguments to a mock town council supporting their opinion on the most suitable use and greatest value for the wetland habitat.

Students are introduced to the fundamentals of what wetland habitats are and how threatened and vulnerable species are defined. They are also provided with a variety of facts on these subjects for Quebec and the implications of habitat loss at a larger scale such as is exemplified by the loss of tropical forests. References are also given to a few resource publications. The leaflet should prove to be a useful teaching and learning tool.

Erich Haber, Botany, Canadian Museum of Nature, Ottawa, Ontario.



Southern exposure: Deciding Antarctica's future.
By Lee A. Kimball. 1990. World Resources Institute, 1709 New York Avenue, N.W., Washington, D.C. 20006, USA, 40 pp. ISBN 0-915825-59-7.

Antarctica is a continent of contrasts, a land of anomalies. It is the harshest of continents with record low temperatures to minus 89.6 degrees Centigrade; the land holds two-thirds of the world's freshwater, while only receiving about 5 cm. of precipitation annually. The ice sheets which blanket the continent are nearly five kilometres thick in some places and extend offshore in "shelves" averaging 215 metres in thickness. As the ice shelves break apart, large icebergs drift northward into the Great Southern Ocean. The number of icebergs adrift in the Southern Ocean (upwards of 200,000), contain more freshwater than the annual freshwater consumption worldwide!

Antarctica is the physical and natural scientists "clean laboratory" providing early warnings of terrestrial, marine and atmospheric pollution. It is a continent worth preserving. Caring for its future will preserve our future.

The World Resources Institute in collaboration with the Tinker Foundation, Inc. has published this excellent condensed survey of the current status of research, management and international participation and accountability in Antarctica. The booklet is divided into eight chapters, each covering a major aspect of Antarctica's importance in global processes, especially as these processes are protected through treaties and recent government and non-government policy measures.

International cooperation has generally been accepted practice in our activities on the continent since 1959 when the Antarctic Treaty (AT) was signed by the twelve signatories. Currently, 38 countries are members in agreement with the AT, fourteen of which (including Canada) are Non-Consultative Parties and may share in all the privileges of the Consultative Parties including full decision-making rights, so long as they are carrying out active, substantial research activities in Antarctica.

The booklet is well written, easily understood, and generally free of legal or political "double-talk" which otherwise might cloud a clearly evident case of protection and sustainable use. The final chapter provides a source list on additional information on Antarctica including several environmental organizations following Antarctic policy development. Further information on Antarctica policies, treaties and environmental issues is available from:

Northern Hemisphere Office
The Antarctica Project
218 D Street S.E.
Washington, D.C. 20003, U.S.A.

"The world's history lies beneath Antarctica's ice mantle. The Planet's future may already be visible in the atmosphere above it." (Lee Kimball).

D.M. Jarzen, Paleobiology, Canadian Museum of Nature, Ottawa, Canada

Tropical lichens: Their systematics, conservation, and ecology.
Edited by D.J. Galloway. Clarendon Press, Oxford. Systematics Association Special Volume No. 43. 302 pp.) £50.

There was a time when we in northern countries such as Canada thought that we could largely ignore tropical plants since they had such a tenuous connection with our own flora. Even if one were to deny the "global village" concept (at our peril) and the impact that the destruction of tropical vegetation can have on those living in northern latitudes, books such as this one bring home the message that many tropical organisms, in this case lichens, are of direct scientific significance in studies of cooler areas.

Galloway's volume is based on the proceedings of a conference with the same title that took place in London in 1989 sponsored by the Systematics Association and the International Association for Lichenology. Although not all the participants contributed to the volume, enough did to make it a most interesting and worthwhile contribution.

The various authors, of course, had a variety of approaches to the subject. Some, such as Elix and Stevens, were classic systematic revisions of tropical taxa; some authors, such as Känefelt and Aptroot, had more general discussions of evolution and phylogeny among tropical taxa; a few, such as Tucker et al. and Wedin, presented observations of morphology and anatomy of tropical taxa; but most of the others contributed floristic discussons of various segments of the tropical lichen flora, listing species and describing floristic elements (e.g., chapters by Smith, Lambley, Krog, Farkas, Arvidsson, Sipman, Marcelli, Wei & Jiang, and Wolsley).

The book is introduced by the editor, **David Galloway**, with detailed overview of the problems of tropical lichenology, and a description of the floristic elements found in th tropics. It is a superb summary with 119 references, and should serve well to launch any lichenologist into the field. The emphasis is made here, as it is in other chapters, that a great deal is still unknown about tropical lichens, despite their potential usefulness as environmental indicators.

Jack Elix then presents an in-depth examination of th systematics and phylogeny of the foliose genus *Relicina*, including chemical characters, which are ranked according to their supposed primitiveness. **Cliff Smith** paints a bleak picture of the state of lichen conservation in Hawaii due to habitat destruction by man. It is fascinating to note that a very large number of lichens in Hawaii are endemic (50% of those on windward rocks, 15% of those in montane cloud forests, etc.) despite the fact that lichens, as a group, tend to be very widespread.

Nell Stevens traces the distributional origins of the *Ramalina* and *Usnea* species in northeast Australia and Papua New Guinea. **P.W.Lambley** does a similar analysis of the macrolichens of Papua New Guinea, together with detailed descriptions of the country, its geography and climate, and the lichens in each of its forest types. **Hildur Krog**, while commenting in general about the macrolichens in the lowland rainforest of eastern Tanzania, describes several new taxa and makes a number of new African reports. Among her interesting observations is the fact that lichens seem to vary from mountain ridge to mountain ridge, a kind of "endemism" that one usually associated more with flowering plants than with lichens.

The follicolous lichens, those lichens growing on the surface of long-lived leaves of vascular plants, get special treatments by **Edit Farkas** dealing with Tanzania, and **J.C. Wei & Y.M. Jiang** with regard to China. It is significant that all the authors emphasize how quickly the tropical flora is disappearing and how much remains to be known about these organisms. **Harrie Sipman**, in his chapter on the lichen flora of the Guianas, also stresses this point, saying that despite a tremendous recent interest in the foliicolous lichens, only 2/3 of his collections could be named to species. This flora is extremely rich with 70 species known from one locality in the Guianas, and 89 foliicolous species from one locality in Columbia!

M.P.Marcelli similarly points out that 1/3 to 1/2 of the species of the Parmeliaceae in Sao Paulo, Brazil, are unidentified, although it is perhaps the most well-known family of foliose lichens world-wide, and habitat destruction is rampant, especially along the coast. **Lars Arvidsson** gives a useful overview of the lichen flora of the various vegetation types in mainland Ecuador. He authored a second chapter in the book, this one on the importance of botanical gardens for lichens in the tropics, pointing out that such gardens serve as a refuge for lichens in severely disturbed habitats and preserve the genetic pool. These arguments, of course, are also used for the vascular plants themselves, and suffer from the same dangers: gardens can be viewed by destroyers of the natural landscape as a "quick fix", allowing them to exploit as much as they want as long as they deposit a few examples of the rarer taxa in horticultural collections. It should be emphasized that, whereas botanical gardens are undoubtedly desirable in raising people's awareness of the wonders of nature, there is nothing that can take the place of a naturally functioning ecosystem, complete with the intricately interdependent array of organisms, including lichens, that can be sustained there. One must preserve not only species, but habitats.

Ingvar Kärnefelt's cladistic analysis of the Teloschistaceae is interesting, although having only tenuous connections with tropical studies; the family has a world-wide distribution, and, although many of his examples are tropical, many others come from temperate and subtropical South Africa. **André Aptroot** goes into cladistic methodology in more detail in his introduction to a phylogenetic analysis of the tropical pyrenocarpous lichens (those lichens in which the mycobiont produces some kind of perithecium). He completes his chapter with a concise key to the genera of tropical pyrenocarpous lichens.

A long and very detailed chapter on the "Lobarion" lichen community is presented by **P.A. Wolesley**. Most interesting to me were the author's comparisons to the floristic and ecological relationships of the temperate and tropical representatives of that community. The effects of man on the assemblage, which is widely used as an indicator of environmental quality, were particularly appropriate for a book on conservation.

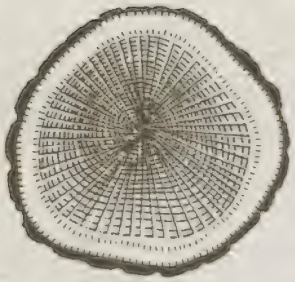
The two chapters on the ultrastructure of tropical lichens are quite different and complementary. **Shirley Tucker, S.W. Mathews** and **R.L. Chapman** concentrate on the relationship of lichen fungi to their photobiont, especially haustorial connections. In the tropics, lichens very often associate with the green algae *Trentepohlia*, *Cephaleuros* or Phycopeltis, and these are the organisms receiving most of their attention. **M. Wedin** deals with the development of the ascospores of two species of *Sphaerophorus* in different subgenera, and he convincingly suggests a new generic classification for these groups.

The book ends with a thoughtful epilogue by **T.D.V. Seinscow**, pointing out the great importance of supporting *local* research efforts in tropical countries, making sure that research results and specimens are returned for the use of local botanists.

Although not covering the field of tropical lichenology in a comprehensive or "synthetic" way, this book contains so much good information that it can be warmly recommended to anyone interested in tropical biology.

Irwin M. Brodo, Botany, Canadian Museum of Nature, Ottawa

Atrichum selwynii *Aust., a moss species endemic to western North America, is common in parts of Canada where it is known from British Columbia, Alberta and a few localities in Saskatchewan, growing on disturbed inorganic soil, especially on road and stream banks and on overturned tree roots. Elsewhere, it occurs from Alaska to California, west to Montana, South Dakota, Colorado and New Mexico. It belongs to the family of Polytrichaceae, commonly known as the "hair-cap mosses" to which* ***Polytrichum*** *belongs and is probably more familiar.* ***Polytrichum*** *species have hairs on their caps (the covering called a calyptra over their capsules or spore cases) but* ***Atrichum*** *differs by lacking hairs and hence the name "A" (meaning without) "trichum" (meaning hair). It is a perennial moss that is dioecious, i.e. the male and female plants are on separarate plants. Male and female plants occur intermingled and the species often produces sporophytes. The species was first collected by John Macoun in British Columbia in 1875 and named for Alfred R. C. Selwyn (1824-1902), Director of the Geological Survey of Canada.*

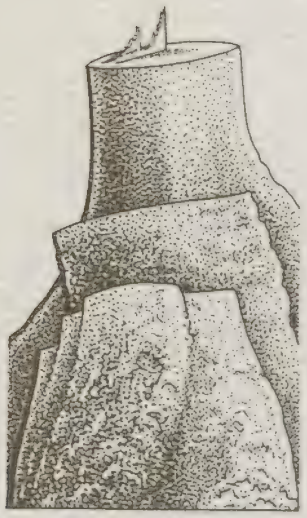


The End of Nature
By Bill McKibben. 1989. Doubleday, 666 Fifth Avenue, New York, NY, 10103, USA. 226 pp. Softcover. ISBN 0-385-41604-0. CAN$ 12.95.

The End of Nature is a discussion of the Earth and its present environmental changes. An entertaining popular science book, it covers scientific understanding, philosophical meanings, and predicted changes in the present and near future of the natural world and how these affect humans. The book explores the solutions and actions presently used to lessen our global environmental problems and suggests difficult and dramatic changes in our habits allowing humanity and nature to coexist.

The Present: A New Atmosphere paints the present global picture of nature and its processes that threaten a change that would affect humans such as an increase in atmospheric CO_2, acid rain, ozone depletion and sea-level rise. The philosophical meaning of nature, the psychological value humans place on nature, and how we would have to adapt if nature were changed are discussed in **The Present: The End of Nature**. **The Near Future: A Promise Broken** presents the effects of changes in nature expected in the future, ranging from minor outcomes to worst-case scenarios. **The Near Future: The Defiant Reflex** explores localized or specialized efforts, which, although admirable, do not scratch the surface of these large-scale global complex changes. **The Near Future: A Path of More Resistance** discusses the most effective actions to alleviate the strain on nature and to slow future changes such as decreasing human consumption and conserving nature. This requires a large shift in our philosophy, society and psychology, and demands a global effort of cooperation and goodwill.

The book is interesting, researched and written well, and is founded on solid scientific basis. **The End of Nature** is a comprehensive essay depicting nature's global changes in a flowing and easily-understood manner, coloured with stories which personalize the narration. The book is biased, as many are, towards the theme of preservation of the human species. In addition, the book brings together many components of global change into a thought-provoking discussion. The writing, while sometimes reaching complex scientific levels, is made readable and reflective for someone with little prior basis of science through associations, parallelisms, and analogies.



The title, **The End of Nature**, sounds pessimistic as if the book were preaching doom. This is misleading. The book is indeed about the end of nature as we know and define it. The title is explained throughout the book in a rational and realistic tone, by sharing understanding and examining available avenues for action. The author acknowledges the difficulty in the adjustments and sacrifices we must make as individuals, as countries, and as a species to coexist and survive with nature in the long-term. Through the understanding of the problem and the presentation of solutions, however extreme, **The End of Nature** provides hope of nature and humans growing together.

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Profile of higher education in Canada / Profile de l'enseignement supérieur au Canada. Education Research and Promotion Directorate, Department of the Secretary of State of Canada. Edition for 1990, published 1991. 51 pp. Obtainable free from: Communication Branch, Department of the Secretary of State, Ottawa, Ontario K1A 0M5, Canada.

The body of this report consists of well-drafted graphs depicting data on various aspects of education in Canada. Each graph is accompanied by a short interpretation of the significance of the graph. Topics covered include enrolement at post-secondary level, institutions and teachers, diplomas and degrees granted, participation, target groups, level of schooling, university graduates and the labour market, expenditures, research and development, and international comparisons.

Some statistics of interest include the following: In 1989, there were 32,144 international students in Canadian universities, slightly more than half at the undergraduate level. Canada has one of the lowest proportions of scientists and engineers per 1,000 inhabitants, ranking behind Japan, United States, Sweden, Netherlands, Germany, France, Australia, and the United Kingdom. Similarly, Canada ranks eighth in expenditures on research and development as a percent of gross domestic product. It is not clear how much the latter figure is explained by the extent of foreign ownership of Canadian industry; industries tend to carry out research in the head-office country. The number of doctoral degrees granted women falls far short of that of men in all major fields of study except education. Canada stands third in public expenditures for education as a percentage of gross national product, behind Sweden and the Netherlands. In 1986 there were 6,000 degrees granted in agriculture and the biological sciences which followed eighth behind social sciences, education, commerce, humanities, engineering, mathematics/physics and health, comprising 5% of all graduates. We know from other sources that biodiversity-oriented graduates comprise a small and shrinking fraction of those in the agriculture-biology category. If biodiversity-based biotechnology is going to be one of the growth industries of the next century, then Canada may not be well placed to take advantage of this opportunity.

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Improving the stability of names: Needs and options
Edicted by D.L. Hawksworth. 1991. Published by the International Association for Plant Taxonomy, in conjunction with the International Union of Biological Sciences, and the Systematics Association. Koeltz Scientific Books, Konigstein/Taurus, Germany. 358 pp., ISBN 0080-0694.

The spectre of dwindling biological diversity, and the irreversible loss of species of organisms, is no longer the concern of the initiated few within the ranks of biology. "Biodiversity" has become both a global issue and a household word. Of similar concern should be the paradoxical decline in interest and support for the study of systematics - the naming and classification of organisms - inasmuch as "Systematic research is basic to any other kind of biological study involving species" (R.M. Feldman and R.B. Manning. 1992. Journal of Paleontology 66: 157-158).

Several factors are held responsible for the decline of systematics at a time when it is sorely needed. One enduring factor, confusing and irritating to amateur naturalists and applied biologists alike, is the instability of scientific names.

An international group of leading nomenclatorists met at the Royal Botanic Gardens, Kew, to discuss the urgent need for improving the nomenclatoral stability of Latin binomials in order to ensure greater permanence and, therefore, utility of names given to organisms. The forty contributions that make up this volume address the issues of user need for stability in names, approaches to stability in names, lists of names in current use, and the registration of names/publications. Most chapters are complex and legalistic, as indeed are the issues they address, and are not intended for lay readership. But readers nomenclatorially inclined, or those asking how the 18th century Linnaean nomenclature can serve 20th century biology in meeting 21st century challenges, will find the discourses in this volume rewarding.

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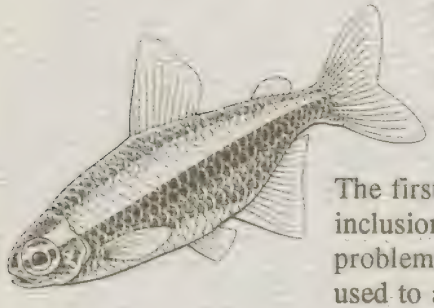
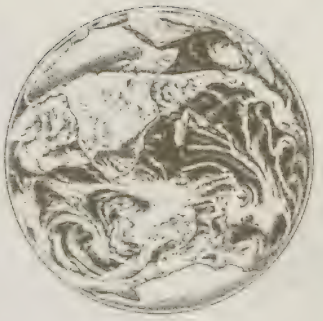
Economics of environmental conservation, economics for environmental and ecological management, developments in environmental economics Volume 1.
By Clement A. Tisdell. 1991. Elsevier Science Publishers B.V., Amsterdam, The Netherlands. Hard cover. 221 pages. Available in the USA and Canada from Elsevier Science Publishing Co. Inc., P.O. Box 882, Madison Square Station, New York, NY 10159, USA. ISBN 0-444-890750-0.

This book, printed in The Netherlands on acid-free paper, presents a great deal of information - theory and applications - on how economics can contribute to environmental conservation. Information and analysis, as described by the table of contents, is given on a wide range of natural resource subjects, including:

* environmental conservation in developing countries
* preservation of wildlife and genetic diversity
* common property and natural resource management
* economics of conserving natural areas: national parks and protected areas
* forestry, trees and conservation
* agriculture and the environment
* tourism, outdoor recreation and the natural environment
* sustainable development and conservation
* population, development and prospects for environmental sustainability.



The first three chapters of the book present a rationale and the economic theory for the inclusion of economics as one of the tools in analyzing and solving environmental problems. The book contains perspectives on most, if not all, the concepts and methods used to analyze environmental conservation issues, from an economics viewpoint. In



addition, that author uses up-to-date examples and discusses current (1990) reports and issue papers from such organizations as IUCN, WWF, UNEP and the World Commission on Environment and Development, which gives the reader a useful perspective on current issues and international organizations.

The author opens with a commonly accepted statement:

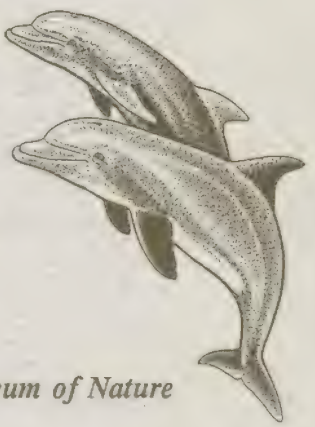
> "Man's welfare and continuing existence depends upon the living environment because, apart from anything else, other species are biologically essential for Man's existence, for example, via the food chain (Owen, 1975)."

and yet finds it necessary to cite a 17 year-old source for the truism. The reader is left wondering if the book will contain any new thoughts or research, or simply continue to make reference to earlier works. An irritating beginning.

The author claims to have written the book with no technical jargon and yet it becomes apparent very quickly that in fact the material would be best viewed as a university text book or general resource volume for the already knowledgeable reader. At least some knowledge of economics is required to understand the book, or the reader must be extremely familiar with environmental conservation and/or resource management issues.

At this point, the reader may be justified in losing sufficient concentration and an interest in carrying on with the book. There are a few unfortunate errors (using "renewable" instead of "non-renewable" on page 14) as well as some questionable terms (what is "intensive deforestation"?). If such terms are legitimate, they should be defined or at least explained. The use of fairly complicated diagrams to illustrate the concepts being described or discussed was found to be more confusing than helpful.

Finally, the author makes the fatal error for an economist: confusing economics and commerce. If the production of a good also creates pollution, warms the atmosphere or creates other unwanted side effects, then it is **by definition** uneconomic unless the **total** benefits (and their distribution) exceed the **total** costs (and their distribution). However, the production of this good may well be **profitable**, in a commercial sense. The terms of reference are different for each. While economics is concerned about profit and loss, it is also concerned with equity and efficiency which goes beyond commercial profitability. The institutional, legal and social parameters of society are all important parts of economics. So when the author writes of "economic production" when in fact he is talking about "commercial production", he is viewing economics in too narrow a light, in my view. To be fair, many economists do this.



A good example of the problem, however, occurs in the introductory section of Chapter 5, where it is stated - "... - yields and economic returns may rise as nature is destroyed and historical results may provide little forewarning of an eventual irreversible collapse of economic production due to the destruction of nature ..". By "economic returns" the author in all likelihood means "financial or commercial returns", and by "economic production", the author presumably means "commercial production". There are few

situations where true **economic returns** can rise as nature is destroyed, nor can I think of much production as **economic** when it leads to the destruction of nature. On the other hand, there are many cases where **financial** returns can rise as nature is destroyed and profits made because of an inadequate policy, regulatory or inspection system overseeing production.

In conclusion, while there is much good material in it, this book is not recommended for general reading. It may best be viewed as a good primer for economic students interested in the subject of environmental conservation, and who do not need to be aware of some of the subtleties involved.

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Wasting assets, natural resources in the national income accounts
By R. Repetto, W. Magrath, M. Wells, C. Beer, F. Rossini. World Resources Institute, Washington, D.C., June 1989. 68 pp. Paper, US$10. ISBN 0-915825-31-7.

> "Conventional national income figures record changes in wealth only when they pass through the market. When a forest is cut down and sold, the country appears to grow richer - even though the trees may not be replaced, and their removal may result in soil erosion, flooding, and the loss of food and fuel gathered by local people." (*The Economist*, January 18, 1992, page 67)

The accounting problem depicted in the quotation from *The Economist*, indicates the importance of accounting for natural resources in national accounts. The report, *Wasting assets, natural resources in the national income accounts*, makes an important contribution to the literature on natural resources and the economy. In fact, the report represents a breakthrough effort that is having, and will continue to have, an important impact on the way in which countries view their wealth in natural resources. Accounting for renewable and non-renewable resource depletion or accumulation and the effect of this on a country's productive capacity (ability to generate wealth), now and in the future, is the central issue of this report.

The report is presented in two main sections: 1. The Need for Natural Resource Accounting, and 2. The Indonesian Resource Accounts. Section one is broken down into five sub-sections dealing with: overview and recommendations; current national income accounting; the scope of natural resource accounting; setting up natural resource accounts; and integrating natural resources into the national accounts. These sections provide the rationale, theory and mechanics (in general terms) of developing and integrating natural resource accounts into systems of national income accounting.

Section two provides an example of the natural resource accounting system as applied to various natural resources in Indonesia. Subsections are presented on: Timber Resource accounts, 1970-1984; Petroleum Resource Accounts, 1970-1984; and Soil Account for Java. A final subsection includes several concluding remarks on the results and the relative ease of implementation.

While it contains much technical material, the report is not particularly difficult to read. It explains well the foundation for the system of natural resource accounting used and exemplified by the Indonesian test case. Other than a tendancy to physically fall apart, the report was well worth reading.

Canada, along with several other countries, is in the process of developing its own accounting system for natural resources and environmental indicators. Being a resource-rich country with different jurisdictions controlling its resources, Canada's system should be fundamentally similar to the one described in this report, but could also be substantially different. Any system developed could have substantial effects upon how we report on the relative wealth of different parts of the country. It will be interesting to see what the Canadian system eventually looks like.

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Biodiversity: Culture, conservation, and ecodevelopment
M.L. Oldfield and J.B. Alcorn (Editors). 1991. Westview Press, Boulder, San Francisco, Oxford. 349 pp. Paper. US$ 41.95. ISBN 0-8133-7680-7.

The volume is a collection of papers read during a symposium on "Traditional cultures and conservation of biological diversity" held during the 1988 Annual Southwestern and Rocky Mountain Division of the A.A.A.S. It contains twenty essays, which can be seen as a "photograph" of the discipline at the time of the symposium.

The consensus view appears to be that: 1) the planetary biosphere may be divided into ecosystems more or less free of human intervention, ecosystems which support hunter-gatherers or traditional agriculturalists, and those supporting industrial agricultures; and 2) that hunter-gatherers/traditional agriculturalists possess knowledge which is valuable for maintaining biodiversity and augmenting food production. Further, the transfer of information between agroindustrial and hunter-gatherer/traditional agricultural societies should emphasize that which is of immediate and specific practical value. Biodiversity is served best when knowledge flows in both directions. Finally, people in all societies desire dependable sources of food, shelter, modern medicine, the pleasures of family life and children, and access to goods produced by modern industrial societies.

Most of the studies relate to Mexico, although a few are taken from the Old World tropics. None refer in detail to ancient and extensively exploited agricultural areas in India and China. There is less quantification than, for example, in studies of plant-animal interaction in game reserves, but the quantification that is present is very stimulalting. One has the impression that the study of interactions between culture and diversity are only a beginning, and much fascinating research can be expected in the future.

There are other implications: a pattern of increasing ecosystem impact has existed through millions of years from the effects of big game, to those of hunter-gatherers (similar to the effects of large carnivores), to those of traditional agriculturalists and to those of industrial societies. The societies which generate the greatest impacts on ecosystems also put at risk those societies which generate lesser impacts, so that a people from the latter tend to move into the former (which on the balance tend more fully to satisfy human desires).

Natural selection seems rather unmerciful in its consequences. However, the process of natural selection between societies need not be unmerciful, as evidenced by the tone of the essays in this volume (written by members of industrial agriculturalist societies). To be sure, there is self-interest in preserving biodiversity, but there is also compassion and the desire to help one's fellows. These qualities are to be found in the traditional beliefs of hunter-gatherers because they stem from the same source, the human conscience. By implementing the dictates of conscience, humankind becomes the partner of biodiversity.

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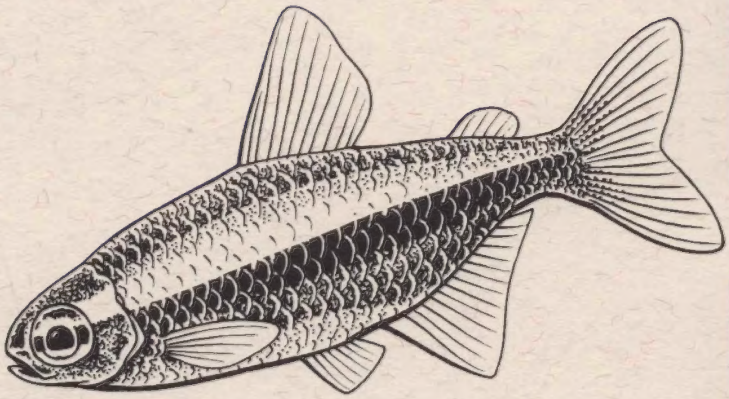

This is the assembly of life that took a billion years to evolve. It has eaten the storms - folded them into its genes - and created the world that created us. It holds the world steady.

Edward O. Wilson (1992) **The Diversity of Life.** Belknap - Harvard University Press

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